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This resource guide contains practical suggestions for teaching of Grade 8 science to the pupils in the Career Guidance Program. The Career Guidance Program was developed for students who are over-age, frustrated, retarded in the school subject, and indifferent to education. The selection and organization of the material parallels the regular course of study for this grade and includes the four prescribed disciplines: chemistry, physics, biology, and earth science. Each discipline is developed in the form of daily lesson plans that consist of (1) the presentation of a problem, (2) the materials required, (3) a suggested procedure, and (4) a pupil worksheet. Each lesson presents concrete laboratory experiences designed to encourage pupil participation. It is suggested that the four disciplines should be taught in the order presented in the manual. (BC)

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Career
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RESOURCE MATERIAL FOR TEACHERS

Science
8th Year

SE005 411

BOARD OF EDUCATION • CITY OF NEW YORK

CURRICULUM BULLETIN • 1967-68 SERIES • NO. 3a

CAREER
GUIDANCE
SERIES

Science
8th Year

BOARD OF EDUCATION • CITY OF NEW YORK

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-FOREWORD-

When planning a science program for all pupils it is important to provide opportunities for them to obtain the techniques of inquiry, the skills needed in research, the basic information related to the area, and the desire to experiment in order that they can function as responsible members of a rapidly advancing technicological age.

In the basic science program for the pupils in the Career Guidance Program special emphasis must be placed on stimulating and sustaining pupil interest to develop the skills and techniques needed for continued technical training.

This guide for teaching science to the 8th grade pupils in the Career Guidance Program develops most skills and concepts through a functional handling of familiar materials and experiences. It presents the teacher with specific teaching aids, materials, and other resources for organizing and presenting learning experiences which encourage a great degreee of pupil involvement. Use of the brochure should enable leaders to meet more effectively the needs of children in the Career Guidance Program.

Hèlene M. Lloyd
Acting Deputy Superintendent of Schools

June 1967

THE CAREER GUIDANCE PROGRAM

The Career Guidance Program grew out of a deep concern on the part of the Junior High School Division for the many pupils who were over-age, frustrated, retarded in most school subjects, and indifferent to education. The typical pupil in this group has a poor self-image, few or no aspirations either academic or vocational, and is biding his time until he can drop out of school.

During the school year 1957-1958, Dr. Joseph O. Loretan,* Deputy Superintendent of Instruction and Curriculum, and Dr. Morris Krugman,** Associate Superintendent of the Division of Child Welfare and five selected and interested principals worked on a plan and structure to create a program for these potential dropouts. In September 1958, six classes were organized in the 7th, 8th and 9th grades of five junior high schools. It was hoped that with specialized and intensive guidance and a curriculum centered around the world of work these pupils would remain in school and be infused with a desire to set higher educational goals for themselves.

In each of these schools a teacher was designated curriculum coordinator to work with the other teachers of these experimental classes to prepare special materials. Most of the schools used the core approach. A job area was chosen as the center of learning, e.g., Garment Trades, Food Handling, etc. All instruction in the various subject areas served to develop and to extend the learnings connected with the particular job area chosen. In September 1960, the Junior High School Division appointed a Job-Placement Supervisor to provide part-time employment for youngsters who wanted to earn money while in school.

Under the supervision of Max Rubinstein, Assistant Superintendent, Junior High School Division ***, this experiment was expanded to include a total of twenty-four junior high schools in September 1962 and thirty junior high schools in February 1963. The program now was organized in the 9th grade, since this was the terminal year of the junior high school and it was at this time that young people had to make a serious decision: Should they go on to high school or should they go to work? Therefore, a concentrated effort had to be made at this point to raise their educational and vocational aspirations if these pupils were to be motivated to seek higher learning. The program was introduced into the junior high schools that requested it. It comprised a unit of three classes, each with a maximum register of fifteen pupils. A full-time advisor was assigned in each school to meet with each class for group guidance twice a week and with every pupil individually at least once a week. An industrial arts teacher was also assigned full-time to instruct the pupils in pre-vocational and avocational skills.

* deceased

** retired

*** District Superintendent, District 29, Queens

In September 1965, the program was introduced into the 8th grade of 17 junior high schools that were reorganized with the 8th grade as the terminal grade. This brought the total number of schools in the program to fifty-two.

Three years of experimentation and a study of similar programs throughout the nation showed that a new teaching approach was essential in every subject area, if these youngsters were to be rehabilitated and redirected. Adaptations or "watered-down" versions of the traditional curriculum without a modified approach presented learning situations which were only too familiar and were filled with the failures and frustrations of the past. It was also evident that once these pupils had spent some time in a Career Guidance class they began indicating that they no longer wanted to go to work; they now wanted to propare themselves for high school.

Thus, in February 1963, a team of specialists in each of the curriculum areas began to work on specially-designed teaching guides in Guidance and Job Placement, Language Arts, Speech, Social Studies, Science, Mathematics, and Industrial Arts. To prepare these guides the curriculum specialists visited each of the schools that had been in the Career Guidance Program from two to five years and studied the teacher-prepared materials in use, observed and conferred with the pupils in the classes, and interviewed the teachers and supervisors to become oriented with the pupils' backgrounds, aspirations, cultures, interests, and needs. Workshop committees composed of teachers, advisors, and assistant principals were organized to work with each curriculum specialist. As the teaching material was developed it was tried out experimentally in selected schools and evaluated.

By September 1963, teaching guides in seven subject areas were made available in mimeograph form to all the schools in the program. The subject matter developed departed largely from the job-centered themes and concentrated on the skills and subject matter necessary for further study in high school; less on theory and more on the functional and manipulative aspects of each subject area so as to present the pupils with true-to-life problems and situations. Beginning September 1963, the area of Office Practice was included to equip the pupils with immediate saleable skills for obtaining part-time jobs and to motivate them toward further vocational work in high school.

Through a continuous program of evaluation by teachers, supervisors, and curriculum consultants, the teaching guides were revised and extended during the year 1965-1966 under the general direction of Martha R. Finkler,* Acting Associate Superintendent, Junior High School Division.

In September 1966, the Career Guidance Series, consisting of teacher guides in Guidance and Job Placement, Language Arts, Speech, Mathematics, Social Studies 1 (You as a Citizen), Social Studies 2 (You and the Working World), Social Studies 3 (You and the World Today), Science -Grade 9, Industrial Arts, and Office Practice, were distributed to the teachers in the program.

* retired

Additional curriculum material has been prepared during the past year (1966-1967). The following experimental teacher resource guides will be distributed to the schools in the program in September 1967: Science-Grade 8; Industrial Arts Supplement; Office and Business Practices; Food, Hospital and Camp Services; and a Reading manual for teachers to be used with Reading-Book 1 and Reading-Book 2 by the pupils.

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- ACKNOWLEDGMENTS -

This teacher resource guide was prepared under the general supervision of Irving Anker, Assistant Superintendent, Junior High Schools; and Helene Lloyd, Acting Deputy Superintendent, Office of Curriculum and Instruction.

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-INTRODUCTION -

This resource guide contains practical suggestions for teaching of grade - 8 science to the pupils in the Career Guidance Program. The selection and organization of the material parallels the regular course of study for this grade and includes the four prescribed disciplines: Chemistry, Physics, Biology, and Earth Science.

Each discipline is developed in the form of daily lesson plans that consist of: the presentation of a problem, the materials required, a suggested procedure, and a pupil worksheet. Each lesson presents concrete and highly motivated laboratory experiences that are designed to encourage as much pupil participation as possible. Every teacher should enrich the lessons by drawing on the interests and experiences of the pupils. This highly structured format is especially helpful to the inexperienced and out-of-license teachers.

It is suggested that the four disciplines be taught in the order presented in the manual as the concepts and skills developed in each area are designed to prepare the pupils for the knowledgesand skills required for the development of subsequent areas.

It is further suggested that the teacher acquaint himself with the content of each lesson well in advance of presentation to prepare the materials and equipment required,to become familiar and competent in their use, and to become aware of the safety precautions involved.

PROPERTIES OF MIXTURES

A. WHAT ARE THE TYPES OF WATER SOLUTIONS?

LESSON 1. What happens when we put different solids into water?

OUTCOMES:

1. Some solids dissolve (disappear) and do not color the water.
2. Some solids dissolve (disappear) and color the water.
3. Some solids do not dissolve (disappear) in water.

MATERIALS:

Teacher Demonstration

500 ml beaker
potassium permanganate
stirring rod
potassium dichromate
copper sulfate

Pupil Materials

flour, salt, sand, sugar
powdered coffee, potassium dichromate
wood splints or spoon
test tube rack with six 8" test tubes
250 ml. beaker half filled with water
marking pencil or gummed labels
rubber stopper to fit on 8" test tube

PROCEDURE:

1. Motivate the lesson by displaying such solids as sugar, table salt, clean sand,flour and colorful solids as copper sulfate, potassium permanganate and potassium dichromate. Ask pupils what they think would happen if each of these solids were put into water.

2. Show pupils that small amounts of some solids will easily dissolve in water and make a deeply colored solution. Add a few crystals of potassium permanganate to a 500ml beaker and stir. Pupils will soon observe the rapid appearance of color in the solution. The teacher may substitute for potassium permanganate either copper sulfate or potassium dichromate.

3. Distribute to each pupil a work sheet and a supply of materials for small groups. Review with students the important parts of the pupil work sheet in order to prepare them to perform the laboratory activities. Encourage pupils to read selected sections of the work sheet silently and ask questions to make certain that they understand what to do. Classes with pupils who have had little or no experience with laboratory lessons could be guided to perform each step as a group.

SUMMARY:

Based on activities of this lesson, guide pupils to see that some solids (solute) will disolve in water (solvent). Others will not (insoluble). Some solutions are clear and colorless. Others are clear and colored.

HOMEWORK:

1. Define each of these words and use them in a sentence.

   solution solute solvent dissolve insoluble

2. Name three different solutions found in your home.

   (hint - coffee , tea)

TEACHER REFERENCES:

Modern Chemistry (high school text)
Holt Rheinhart Winston page 278

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR EACH PUPIL)

LESSON 1. What happens when we put different solids into water?

MATERIALS:

several samples of labeled solids
wood splint or spoon to measure out and transfer samples of solids
test tube rack with six 8" test tubes
250 ml. beaker half filled with water
marking pencil or gummed labels
rubber stopper to fit on 8" test tube

PROCEDURE:

1. Mark each test tube with your marking pencil as follows: F=flour, C=coffee, S=sugar, Sa=salt, Sd=sand, D=potassium dichromate

2. Use your wood splint or plastic spoon to put enough of each solid into a labeled test tube to fill the rounded bottom of the test tube.

3. Fill each test tube about ½ full of water from your supply in the beaker.

4. Close each test tube with a rubber stopper and shake it. (Be sure to clean your stopper each time you use it.)

5. After a few minutes inspect each test tube to see what happened.

Example of solid	Did the solid dissolve yes -no?	Is its appearance cloudy, clear, colored, colorless?	Was a solution formed yes - no?
Salt - Sa			
Sugar - S			
Sand - Sd			
Flour - F			
Dichromate - D			

From what you saw in the lesson tell what you think a solution is.

Underline the correct word in each sentence.
a) A solution is (cloudy, clear)
b) A solution (does, does not) settle out at standing.

SUMMARY:

1. A solution can be a mixture of a solid and liquid in which the solid has disappeared.
2. Some solids dissolve in water and disappear.
3. Other solids do not dissolve.
4. Some solutions are clear and colorless, others are clear and colored.

A. WHAT ARE THE TYPES OF WATER SOLUTIONS?

LESSON 2. How would you know a good mixer if you saw one?

OUTCOMES:

1. Some liquids form a solution when mixed with water.
2. Solutions are the same all the way through.

MATERIALS:

a) Teacher Demonstration

blue litmus paper
dilute HCl (hydrochloric acid) solution
500 ml beaker

b) Pupil Materials

alcohol, corn oil, vinegar, kerosene
syrup, hand lens, marker, 5 small test tubes
250 ml beaker, stirring rod, test tube rack
5-8" pieces of glass tubing or 5 medicine droppers

PROCEDURE:

1. Ask pupils what they think we mean by a good social mixer. Elicit the idea that a good social mixer is a boy or girl who gets "in with the crowd" at a party or other gathering. He or she becomes so much a part of the crowd that he or she isn't seen as a person apart anymore. Relate this to the lesson by asking a question such as: How can we show that water is the greatest mixer of them all? Point out that many solids or liquids can not be seen after they're mixed with water.

2. Test tap water with blue litmus paper. Tell pupils that the litmus paper will change colors if it is placed in certain things. Elicit that no change takes place with water. Test a small amount of dilute HCl acid solution with blue litmus paper. (Caution: Do not let the acid solution touch your clothes or hands). Elicit that a change does take place now. (from blue to red). Fill a large beaker or other glass vessel 3/4 full of water and test the water with blue litmus. Add about 5 ml. of dilute HCl, stir and test again. Have some pupils come up to examine the solution of HCl. Ask then to describe what it looks like. Guide the pupils in reaching the conclusion that it has the characteristics of a solution because the acid mixed with the water so that you can not see the acid anymore or distinguish it from the water.

3. Ask the pupils "How can we find out whether other liquids will form solutions when mixed with water?" Their replies should help the teacher lead into the pupil activity described below.

4. Distribute to each pupil a work sheet and a supply of materials for small groups. Review with students the important parts of the pupil work sheet, in order to prepare them to perform the laboratory activities. Encourage pupils to read selected sections of the work sheets silently and ask questions to make certain that they understand what to do. Classes with pupils who have had little or no experience with laboratory lessons could be guided to perform each step as a group.

SUMMARY:

1. When a liquid can be mixed with water so that the liquid can not be seen anymore, we have a solution.

2. The mixture of the liquid and water is the same all the way through.

Note:

If available, 5 medicine droppers per set-up would reduce contamination of each liquid (Solute). Otherwise, 5 pieces of glass tubing could be used to transfer the different liquids. If it is necessary to use only one medicine dropper, be sure to instruct the pupils how to rinse and dry the dropper before adding other solutes.
The 8" lengths of glass tubing can be used to transfer the liquid by dipping the tubing into the liquid to be transferred, covering the end of the piece of tubing not in the liquid, and transferring it to the test tube. The liquid will flow out of the tubing when the finger is released from the top of the tubing.

HOMEWORK:

1. Does the alcohol and water look like the corn oil and water? Why?

2. Put some orange juice in a glass of water.

   a) What happens to orange juice when we mix it with water?
   b) If we let it stand for 10 minutes would the top half taste like water? Why?
   c) Is orange juice a solution? How do you know? (Note: Yes and no. It tastes sweet yet we do not see the sugar which is a white solid. But the juice has solids suspended in it.)

PUPIL WORKSHEET

LESSON 2. How would you know a good mixer if you saw one?

MATERIALS:

alcohol, corn oil, vinegar, kerosene
syrup, hand lens, marker or labels, 5 small test tubes
250 ml. beaker, stirring rod, test tube rack
5 8" pieces of glass tubing or 5 medicine droppers

You will find samples of some liquids on your tray. You will also find 5 test tubes.
Mark or label each test tube as follows: on one test tube put A for alcohol, on another put C for corn oil, on the third write V for vinegar, on the fourth put S for syrup, and on the fifth put K for kerosine.
Put some of each liquid into the appropriate yesy tube - about enough to fill the rounded bottom of the test tube.
Now add enough water to each test tube so that it is 3/4 full of water.
Using the stirring rod, stir the liquids in the test tubes until they are well mixed.
Hold each test tube up to the light and look at it with a hand lens.
Tell what you saw using the chart below by putting a circle around the correct answer.

Mixtures	How does it look?		Did the liquid disappear?		Is it a solution?	
alcohol + water	clear	cloudy	yes	no	yes	no
corn oil + water	clear	cloudy	yes	no	yes	no
vinegar + water	clear	cloudy	yes	no	yes	no
kerosine + water	clear	cloudy	yes	no	yes	no
syrup + water	clear	cloudy	yes	no	yes	no

PROPERTIES OF MIXTURES

A. WHAT ARE THE TYPES OF WATER SOLUTIONS?

LESSON 3. Why does an open bottle of "soda pop" give off bubbles of gas?

OUTCOMES:

1. Gases can be dissolved in water.
2. When the temperature of water is raised, less gas can be dissolved in the water.
3. When the temperature of the water is lowered, more gas can be dissolved in the water.

MATERIALS:

Teacher Demonstration

two unopened bottles of club soda (one cold, one at room temperature)
brom thymol blue (an indicator of the presence of carbon dioxide)

Pupil Materials

250 ml beaker one half full of cool tap water
thermometer inserted into a one hole rubber stopper
clamp to hold the rubber stopper and thermometer
alcohol burner
ring stand and ring with wire gauze

PROCEDURE:

1. Motivate the lesson by displaying two unopened bottles of "club soda". One should be cold, the other at room temperature.

   Label the respective bottles with signs "warm", "cold". Ask,"Can you see any difference in the water of the unopened bottles?" After agreeing that both bottles look alike, that is, no bubbles are visible, the teacher will ask the students to carefully observe what happens when the bottles are opened. The following will happen - many bubbles will appear readily in the warm bottle of soda whereas, by contrast, hardly any bubbles will appear in the cold bottle.

   Elicit that the soda water in the warm bottle cannot keep the bubbles in solution as long or as well as the cold bottle of soda water. Ask, "Why does an open bottle of soda water left standing in a warm room for several hours lose its zip and taste, or go "flat?"

   Have the pupils feel the bottles again and ask them to suggest why one bottle gave off more gas than the other.

2. To show that the gas given off is carbon dioxide, pour some soda water into a solution of brom thymol blue. A greenish yellow color change indicates the presence of carbon dioxide.

   NOTE: You may wish to show that brom thymol blue will change to greenish yellow in the presence of CO_2. You may do this by using a CO_2 gas generator (baking soda and water) and bubble the gas through the solution of brom thymol blue.
   Compare this with the soda and the brom thymol blue.

3. Distribute pupil worksheets and equipment to groups of pupils. Guide the pupils in reading the worksheets and preparing their experiments.

SUMMARY:

1. Gases can be dissolved in water.
2. More gas can be dissolved in cold water than in warm water.
3. As the temperature of the water is lowered, the gas stays in solution longer, and as the temperature of the water is raised, less gas stays in solution.

HOMEWORK:

Have the pupils complete the homework assignment listed on the pupil worksheet.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON: 3 How can some gases form a solution with water?

MATERIALS:

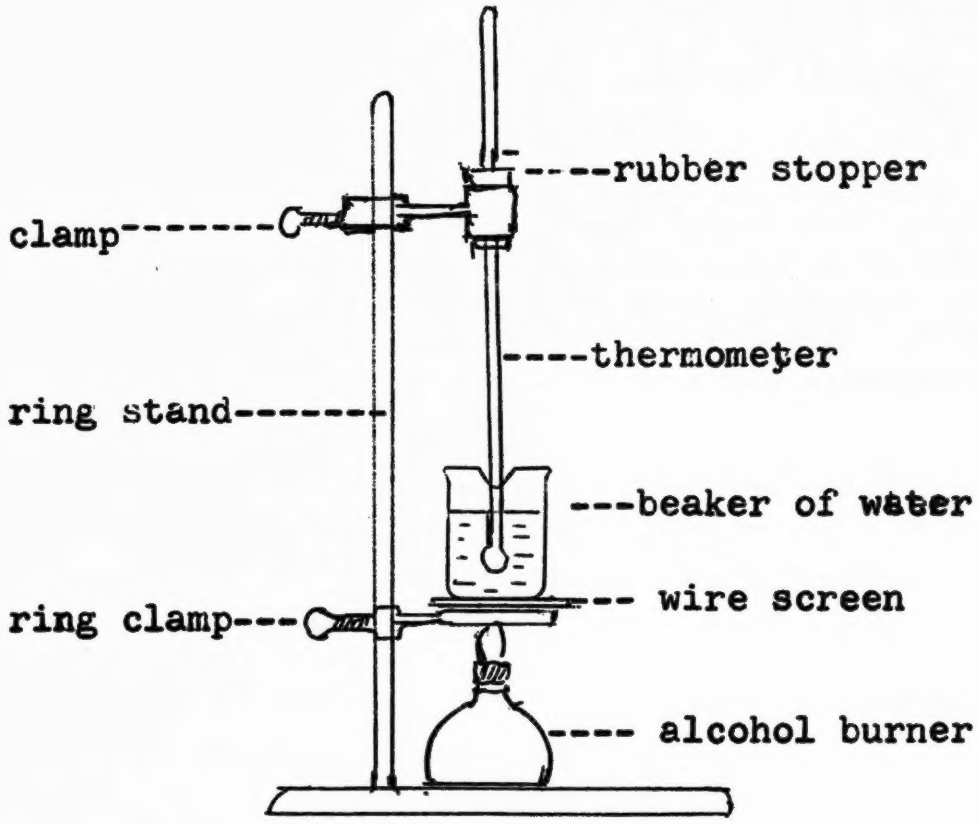
250 ml beaker one-half full of cool tap water
thermometer inserted into a one hole rubber stopper
clamp to hold the rubber stopper and thermometer
alcohol burner
ring stand and ring wire guaze

PROCEDURE:

Put together the apparatus as shown in the diagram below.

1. Put the ring with the wire screen on it about one inch above the top of the alcohol burner.
2. Put the beaker of water on the screen. (1/2 beaker of water)
3. Put the rubber stopper with the thermometer into the clamp.
4. Place the clamp on the ring stand so that the bulb of the thermometer is deep into the water, but not touching the bottom of the beaker.
5. Light the burner and make a record of the temperature at the start of the experiment and again when the bubbles of gas begin to form on the sides of the beaker.

Caution: Do not bring the water to a boil. Be sure to put out the flame on the burner when you remove it from the ring stand.



From what you did in this experiment and what you saw in this lesson complete the following:

1. The soda water in the warm bottle had (more, less)____________ bubbles than the soda water in the cold bottle of soda.

2. When the tap water I was heating began to get warm, I saw _______ of air appear on the walls of the beaker.

3. Cool tap water (has, has no) ____________ air dissolved in it.

4. The lesson showed that cool tap water (is, is not) _________ a solution of air and water.

5. The lesson showed that less air is able to be held in solution when the water is (cool, warm) _________.

HOMEWORK:

Do the following experiment at home.

Place a glass full of tap water in a warm spot.(Cover the glass with a saucer to prevent the water from becoming dirty). Allow the glass to stand for at least three hours. Make a record of the amount of bubbles forming on the inside of the glass at half hour intervals.

1/2 hr	1 hr	1 1/2 hrs	2 hrs	2 1/2 hrs	3 hrs

Explanation - Circle the correct word.

The longer the water in the glass stood the (warmer, colder) it became, and the (more, less) bubbles of air collected on the inside of the glass. This showed that ordinary tap water (does have, does not have) air dissolved in it.

Can you explain the following: Fish live by using the dissolved air in the water. Tropical fish (those that live in warm water) live best in water which is kept at a temperature of 65 - 75 degrees Fahrenheit. In most tropical fish tanks the water temperature is kept at this level by an automatic heater. What might happen to fish if the temperature should become about 100 degrees.

B. WHAT ARE SOME IMPORTANT CONDITIONS AFFECTING SOLUTIONS?

LESSON 4. How can we change solids so that they can dissolve more quickly?

OUTCOMES:

1. Smaller particles of a solid will dissolve faster than larger particles of the same solid because more surface of the solid comes in contact with the water (solvent).
2. Stirring will make the solid dissolve faster because there is a more complete mixing of the water (solvent) and the solid particles.

MATERIALS:

Pupils

four 100 ml beakers with water
four vials (or 4" test tubes) each containing 3 grams of copper sulphate
stirring rod
mortar and pestle
large glass clock with a second hand

PROCEDURE:

1. Motivate the lesson by questioning the pupils about the things they do in order to make things dissolve faster. Ask,"Why do we stir our coffee or tea after putting sugar into it?" Ask pupils what other ways solids can be made to dissolve more quickly. Elicit the fact that making the pieces of solid smaller will make them dissolve more quickly.

2. Draw a chart on the blackboard like the one on the pupil worksheet. After the laboratory exercise is finished, you may have one pupil come to the blackboard and copy his results on the chart. Lead a class discussion of the results in order to guide pupils in understanding two ways that things can dissolve more quickly.

3. Distribute the trays containing the following materials to groups of pupils. Guide the pupils as to how the experiment will be conducted. Help them read the instructions on the worksheet.

4. In this experiment the pupils will dissolve copper sulphate crystals in water and note that the finely ground ones dissolve more quickly. They will also note that stirring makes the copper sulphate dissolve more quickly.

SUMMARY:

Encourage pupils to explain why:

1. Smaller pieces of a solid dissolve more quickly than larger pieces.
2. Stirring the water makes the solid dissolve more quickly.

HOMEWORK:

Ask the pupils to complete the questions on the pupil worksheet.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 4. How can we make things dissolve faster?

MATERIALS:

four 100 ml beakers with water
four vials (or 4" test tubes) each containing 3 grams of copper sulphate crystals
stirring rod
mortar and pestle
large glass clock with second hand

PROCEDURE:

Find out how long it takes for the copper sulphate to dissolve in each of the experiments. Use the boxes in the chart below to write your results:

A. The time you put the copper sulphate in the water.

B. The time when all of the copper sulphate dissolved.

C. How long it takes to dissolve.

EXAMPLE

Time the solid was all dissolved: 12.07
minus
Time the solid was put into water: 12.02

How long it took to dissolve: 5 minutes

Step 1.
- a) Take a vial of copper sulphate crystals and pour it into a 100 ml beaker, 3/4 filled with water, and stir. Write down the time in the table below.
- b) Record on the chart the time when you put the copper sulphate into the water.
- c) Record on the chart the time when all of the copper sulphate dissolved.

Step 2.
- a) Take a second vial of copper sulphate crystals and pour the crystals into the mortar. Use the pestle to grind them into a powder.
- b) Pour all of the powder into another beaker of water and stir.
- c) Record on the chart the time when you put the powder into the water.
- d) Record on the chart the time when all the powder dissolved.

Step 3.

a) Take the third vial of copper sulphate and pour it into a beaker with water.
   DO NOT STIR.

b) Record on the chart the time when you put the copper sulphate into the water.

Note: Do not wait for the copper sulphate to dissolve. Go on to step 4.

Step 4.

a) Take a fourth vial of copper sulphate and pour it into a beaker of water and stir.

b) Record on the chart the time when you put the copper sulphate into the water.

c) Record on the chart the time when all of the copper sulphate dissolved.

Activity	Big pieces of copper sulphate	Small pieces of copper sulphate	Copper sulphate not stirred	Copper sulphate stirred
Time when it has all dissolved				
Time poured				
How long it took for crystals to dissolve				

HOMEWORK:

Complete the following questions:

1. In the experiment we did today, we found that a (large, small)__________ crystal dissolved faster in water.

2. Grinding up crystals helps things dissolve (faster, slower)____________.

3. Things will dissolve faster by (standing, stirring) __________________.

4. Write 2 ways we can help things dissolve faster.

   a) ________________________________

   b) ________________________________

B. WHAT ARE SOME IMPORTANT CONDITIONS AFFECTING SOLUTIONS?

LESSON 5. Can hot coffee be sweeter?

OUTCOMES:

1. Most substances will dissolve more easily in hot water than in cold water.
2. As the temperature of water goes up, more of a solid substance can be dissolved.

MATERIALS:

Pupil

three 4" test tubes each containing a few (less than 5) potassium permanganate crystals.

Note: It is absolutely necessary that each of the test tubes contain the same amount of potassium permanganate solid.

test tube rack
tripod, ring clamp and wire quaze
alcohol burner
small glass funnel for the 4" test tubes
100 ml beaker half filled with water
6" test tube filled with cold tap water
tongs

PROCEDURE:

1. Recall from the previous lesson the two methods which can be used to make substances dissolve more easily. Refer to the aim of this lesson and ask pupils why hot coffee can be made sweeter than cold coffee. Encourage pupils to make suggestions as to whether hot water can dissolve more of a solid than cold water. Ask them to suggest ways of finding out.

2. Explain that in today's experiment pupils will find out what effect the temperature of the water has on the amount of a solid substance which can be dissolved.

3. Distribute pupil worksheets and materials to small groups of pupils. Assist the pupils in reading the instructions and understanding what they are to do. A model of the equipment set-up will allow pupils to compare their work to the one on the teacher's table.

SUMMARY:

Encourage pupils to explain why:

1. Most solids will dissolve more easily in hot water than in cold water.
2. As the temperature of water rises more of the solids will dissolve.

HOMEWORK:

1. What three ways have you learned to make things dissolve faster?
2. Underline the word which does not belong in the group of words:
   a) temperature of water, size of solid, color of solid, mixing
   b) hot water, more dissolved, small pieces, cold water

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

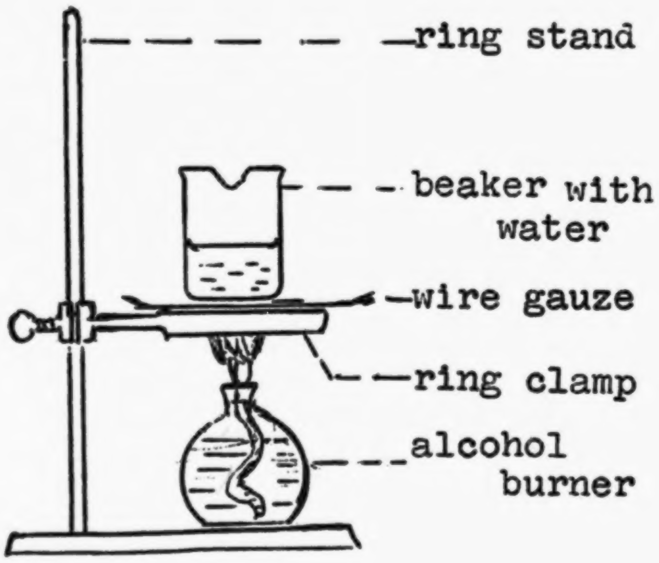
LESSON 5. What happens when we use hot water instead of cold water to dissolve a solid?

MATERIALS:

three 4" test tubes containing a few (less than 5) potassium permanganate crystals

Note: Make sure that each of the test tubes contain the same amount of potassium permanganate solid.

test tube rack
tripod, ring clamp and wire gauze
alcohol burner
small glass funnel for the 4" test tubes
100 ml beaker half filled with water
6" test tube filled with cold tap water
tongs



PROCEDURE:

1. Place the wire gauze on the ring clamp and the beaker with water on top of the gauze. Light the alcohol burner and heat the water until it boils.

2. Use the tongs to pick up the beaker of boiling water and pour the water into one of the 4" test tubes until it is 3/4 full. Use the glass funnel. Pour the hot water from the beaker into the second 4" test tube until it is a little more than 1/4 full. Add cold water from the 6" test tube until this 4" test tube is 3/4 full.
Pour the cold water from the 6" test tube into the third 4" test tube until it is 3/4 full.

3. Watch the three 4" test tubes for about 5 minutes and observe the color change in each one.

Complete the following questions by placing an (X) in the space you think is right.

1. Which one of the three 4" test tubes had the darkest color?

    The test tube with the boiling water ____________
    The test tube with the cold water ____________
    The test tube with the hot and cold water mixed together ____________

2. Which one of the 4" test tubes had the hottest water?

    The test tube with the boiling water ____________
    The test tube with the boiling water and the cold water mixed ____________
    The test tube with the cold water ____________

3. The test tube with the darkest color had (more, less)____________ solid dissolved than the test tube with the lightest color.

4. From what you learned in today's experiment write one way to make things dissolve faster.
    ____
    ____

PROPERTIES OF MIXTURES

B. WHAT ARE SOME IMPORTANT CONDITIONS AFFECTING SOLUTIONS

LESSON 6. What other solvents besides water are there?

OUTCOMES:

1. Water is not the only solvent.
2. Solvents serve many useful purposes.

MATERIALS:

Pupil

test tube rack
four 6" test tubes
100 ml. beaker 1/3 filled with benzene
100 ml. beaker 1/3 filled with corn oil
butter

PROCEDURE:

1. Motivate the lesson by asking pupils how they take food stains out of their clothes. Elicit the fact that water will not always take stains out of their clothing. Encourage pupils to tell the class some of the ways they take stains out. As a result of the discussion develop the concept that water is not the only substance which can dissolve things.

2. Demonstrate that alcohol can also be used to dissolve substances. Fill one 500 ml. graduate cylinder 3/4 full of water and another 500 ml. graduate cylinder 3/4 full of alcohol. Using the carbon paper from a rexograph master cut two strips 1" wide and 3" long. Drop one strip into each of the graduate cylinders and ask pupils to report what they observe.

3. Explain to pupils that in today's experiment they will see how well another liquid besides water can be used to dissolve solids.

4. Distribute the trays containing the materials listed above to groups of pupils. Guide the pupils as to how the experiment will be conducted. Help them read the instructions on the worksheet.

SUMMARY:

1. After the pupils have completed their work, guide them to conclude that water is not the only solvent. Other liquids are necessary to dissolve many "water-insoluble" solids and liquids.
2. Lead the discussion to an application of these important ideas by relating to the materials used in dry-cleaning, petroleum industry and the ever expanding plastics industry.

HOMEWORK:

Have the pupils do the experiment outlined in the pupil worksheet.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 6. What other solvents besides water are there?

MATERIALS:

test tube rack
four 6" test tubes
100 ml. beaker 1/3 filled with benzene
100 ml. beaker 1/3 filled with corn oil
butter

PROCEDURE:

In today's experiment you will use another liquid to dissolve solids which do not dissolve in water.

1. Take a 6" test tube half filled with benzene and add enough corn oil so that the test tube is 3/4 full. Use a stirring rod to mix the two liquids. Show what you saw happen by circling the correct word in the chart below.

2. Take a 6" test tube half filled with water and add enough corn oil so that the test tube is 3/4 full. Mix the two liquids with a clean stirring rod. Circle the correct word on the chart below to show if corn oil did or did not dissolve in water.

3. Take a 6" test tube half filled with benzene and add a piece of butter (not margarine) the size of a pea. Use a stirring rod to to try to dissolve the butter. Circle the correct word on the chart below to show if the butter did or did not dissolve in the benzene.

4. Take a 6" test tube half filled with water and add a piece of butter (not margarine) the size of a pea. Use a stirring rod to try to dissolve the butter. Circle the correct word on the chart below to show if the butter did or did not dissolve in the water.

corn oil in benzene	butter in benzene	corn oil in water	butter in water
did dissolve	did dissolve	did dissolve	did dissolve
did not dissolve	did not dissolve	did not dissolve	did not dissolve

HOMEWORK:

1. Underline the correct word or words.

   a) Butter will disolve in (benzene, water).
   b) Corn oil will dissolve in (benzene, water).

2. Complete the following sentence:

   Water is a liquid which can dissolve things. ________________ is another liquid which can dissolve things.

3. Do the experiment below at home.

   Try to dissolve corn oil or butter in another liquid (like benzene) such as turpentine.

C. HOW CAN THE PARTS OF A SOLUTION BE SEPARATED?

LESSON 7. How would you get the salt out of the ocean?

OUTCOMES:

1. The parts of a solution can not be separated by filtering.
2. The solute can be separated from the solvent if the solution is evaporated to dryness.
3. This is one way we can "get back" many valuable things found in the ocean.

MATERIALS:

Teacher

a solution of copper sulfate
funnel and filter paper to fit
ring stand
ring clamp

Pupil

solution of sodium chloride (1/3 of a test tube)
alcohol burner
ring stand
ring with wire gauze to fit

PROCEDURE:

1. Display a filtering set-up and ask pupils to suggest what would happen to the blue color if you tried to filter a solution of copper sulfate. After you have performed the filtering, ask them to form conclusions about the effect of filtering on separating parts of a solution. Ask them to suggest other ways that might be more successful.

   Clue - Recall what happens when they swim in salt water and then dry out in the sun. "How did their skin feel?" "What did the sticky white powder taste like?"

2. Direct their attention to the pupil worksheet and discuss the steps in the experiment to find out how to recover a salt from a solution.

3. Distribute worksheets and materials to small groups of pupils. Guide them in preparing the equipment and in following the steps of this exercise.

SUMMARY:

1. The parts of a solution can not be separated by filtering.
2. The solute can be recovered if the solution is evaporated to dryness.

HOMEWORK:

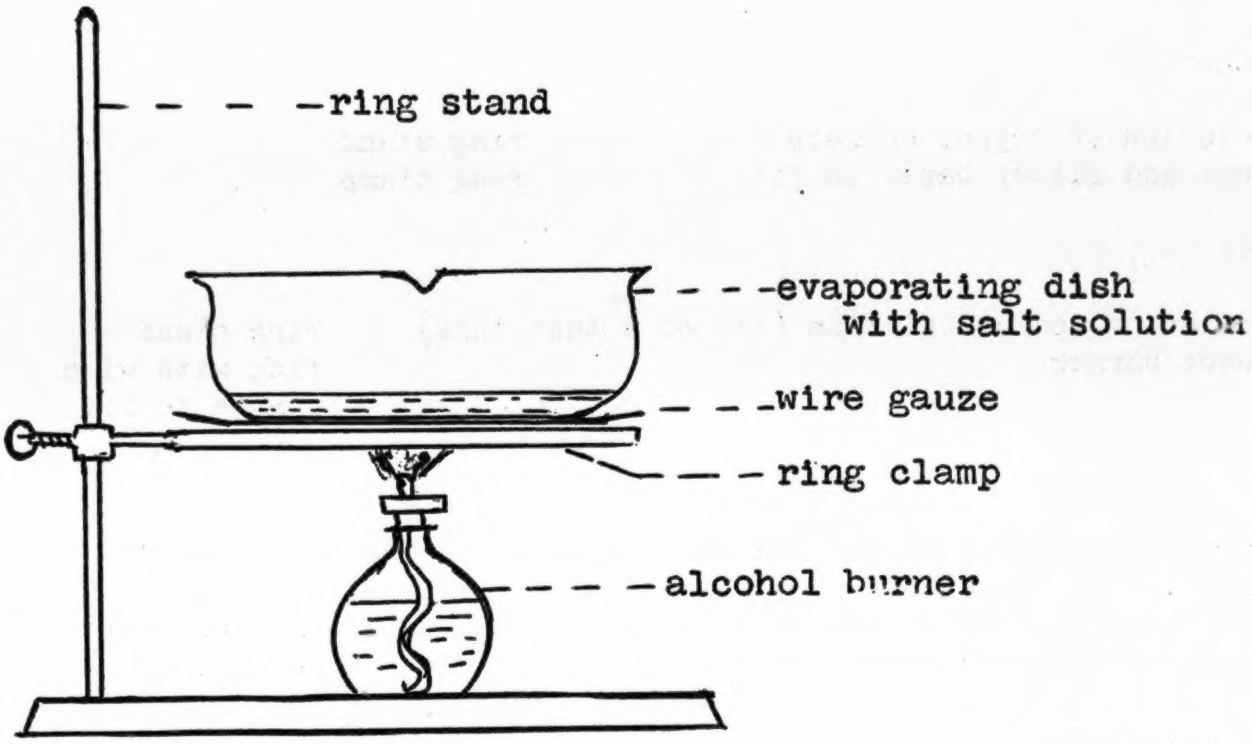
Have pupils complete the questions on the worksheet.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 7. How would you get the salt out of ocean water?

MATERIALS:

- ring stand
- evaporating dish
- wire screen
- ring clamp
- alcohol burner
- 1/3 of a test tube of salt solution


ring stand
evaporating dish with salt solution
wire gauze
ring clamp
alcohol burner

PROCEDURE:

1. Set up the equipment as shown in the diagram above.
2. Place the evaporating dish on a wire guage about one inch above the alcohol burner.
3. Pour the salt solution from your test tube into the evaporating dish.
4. Light the alcohol burner and carefully heat the dish until the liquid has evaporated completely. Let it cool!
5. Examine the solid that remains. What do you think it is?
6. With the tip of your finger, carefully pick up a tiny piece of the solid and touch it to your tongue. What does your taste tell you this is?

QUESTIONS:

1. A solution of a solid and a liquid can be separated by (filtering, evaporation) ______________.

2. When is filtering used? ____
____

3. When is evaporation used? ______________________________________
____

4. Name two things in your home you would separate by filtering-(example:soup)

   a)
   b)

4. Name two things in your home you would separate by evaporation - (example: sugar from tea).

   a)
   b)

C. HOW CAN THE PARTS OF A SOLUTION BE SEPARATED?

LESSON 8. How do crystals differ from one another?

OUTCOMES:

1. Crystals of the solute are formed when a solution evaporates.
2. Crystals have a definite shape but no definite size.
3. Crystals of one substance all have the same shape.
4. Crystals of different substances may have different shapes.

MATERIALS:

Teacher

some large crystals of copper sulfate, quartz, or other crystals (these may be obtained from the Earth Science Stock)
microscope and slides (a bioscope is excellent if available)
medicine dropper
concentrated solutions of sodium chloride and magnesium sulfate and copper sulfate

Pupil

microscope and slides
medicine dropper
small test tube of concentrated salt solution
small test tube of concentrated magnesium sulfate

PROCEDURE:

1. Motivate the lesson by displaying some large crystals of copper sulfate, quartz, or any others that may be available.

2. Elicit as to how these might have been formed.

3. Have pupils recall from the previous lesson #7,("How would you get the salt out of the ocean?"), how the solute was recovered from the solution.

4. Explain that solids usually separate from solutions as crystals.

5. Crystals of one particular substance all have the same structure. (for example all salt crystals look alike)

6. Tell the pupils that they are going to see the formation of crystals while the water of a solution evaporates from a slide when it is on the stage of a microscope.

   (If a bioscope is available the crystal formation may be demonstrated on the wall screen.) The drop of salt solution is placed on the slide and the heat from the lamp will quickly evaporate the solution showing the crystal formation. Have the pupils note the shape of the crystals and draw them in their notebooks.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 8. How do crystals differ from one another?

MATERIALS:

microscope
two slides
medicine dropper
concentrated solution of solium chloride
concentrated solution of magnesium sulfate

PROCEDURE:

1. Your teacher will show you how to set up your microscope properly.
2. Use your medicine dropper to place a drop of salt solution on a slide. Spread the drop on the slide by drawing your medicine dropper across the slide.
3. Place the slide on the stage of the microscope as soon as possible.
4. Observe the evaporation and the crystal formation through the microscope while the water is evaporating.
5. Make a drawing of the crystal of salt.
6. Follow the same steps with a drop of magnesium sulfate solution. Note the crystal formation and make a drawing of the crystal of magnesium sulfate.

Complete the following statements:

1. When a solution evaporates, the solute(remains behind, evaporates) ____________________.
2. When a crystal of a substance is formed it is (pure, impure) __________ substance.
3. All crystals of salt have the (same, different) ____________ shape.
4. Crystals of salt are the (same, different) ____________ in shape from crystals of magnesium sulfate.

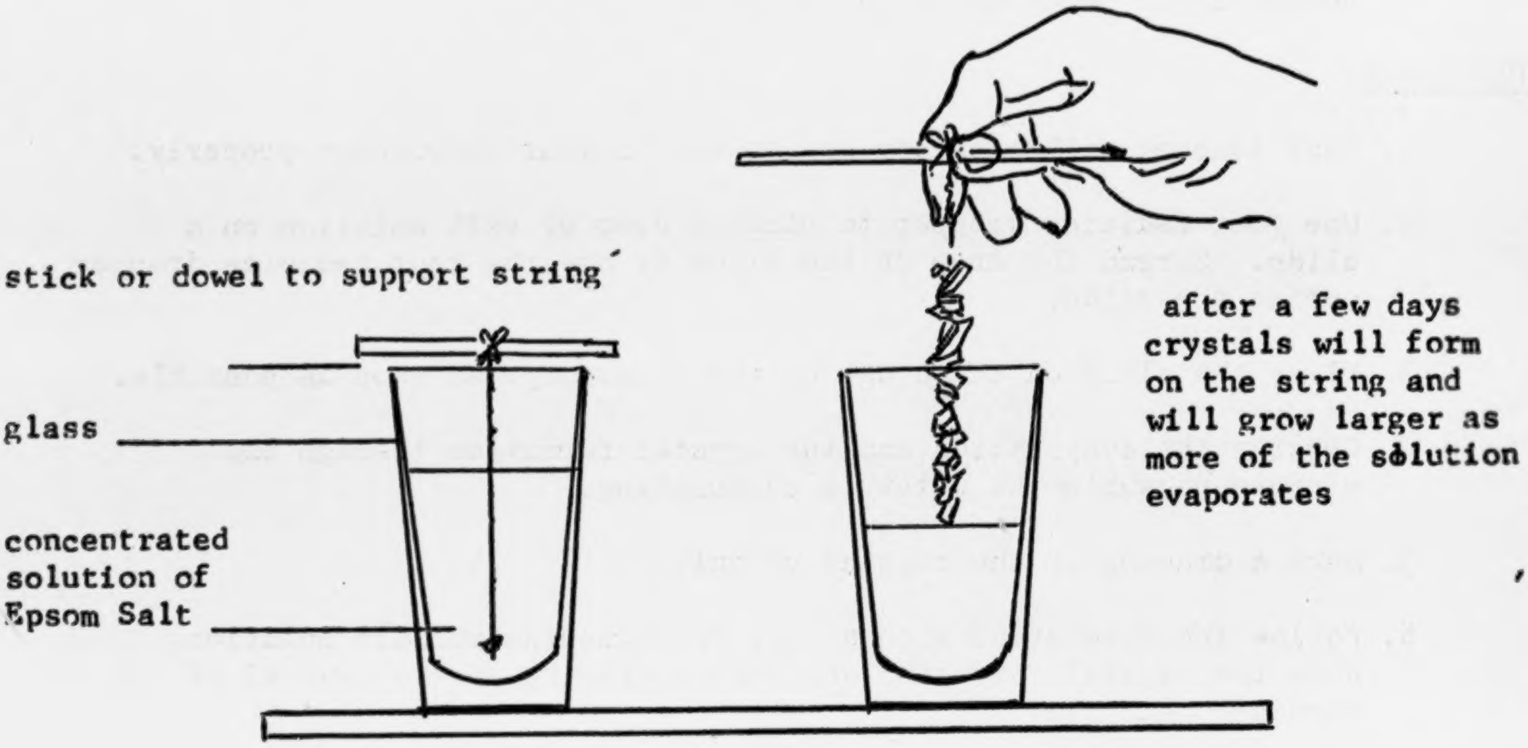
HOMEWORK:

You may wish to grow crystals at home with inexpensive materials. This may take several days but is well worth a try.

Dissolve as much Epsom Salt as you can in a pint of hot water. When no more salt will dissolve remove the water solution to safe place and allow it to cool. Place a crystal of the Epsom Salt into the saturated solution (which has been cooled to room temperature after a few days) and watch the crystal grow. Do not disturb the solution for a few days and again note the growth.

LESSON 8.

How to set up your crystal-growing experiment at home.


stick or dowel to support string
glass
concentrated solution of Epsom Salt
after a few days crystals will form on the string and will grow larger as more of the solution evaporates

C. HOW CAN THE PARTS OF A MIXTURE BE SEPARATED ?

LESSON 9. How can we get the water (solvent) in a pure form out of a solution?

OUTCOMES:

1. Heating a solution to boiling changes the liquid part of a solution to a vapor.
2. Changing the vapors back to a liquid by cooling the vapors is called condensation.
3. The steps, vaporizing, condensing, and collecting the cooled vapors in a separate container is called distillation.
4. The process of distillation is a method by which a chemically pure form of the liquid solvent can be recovered.

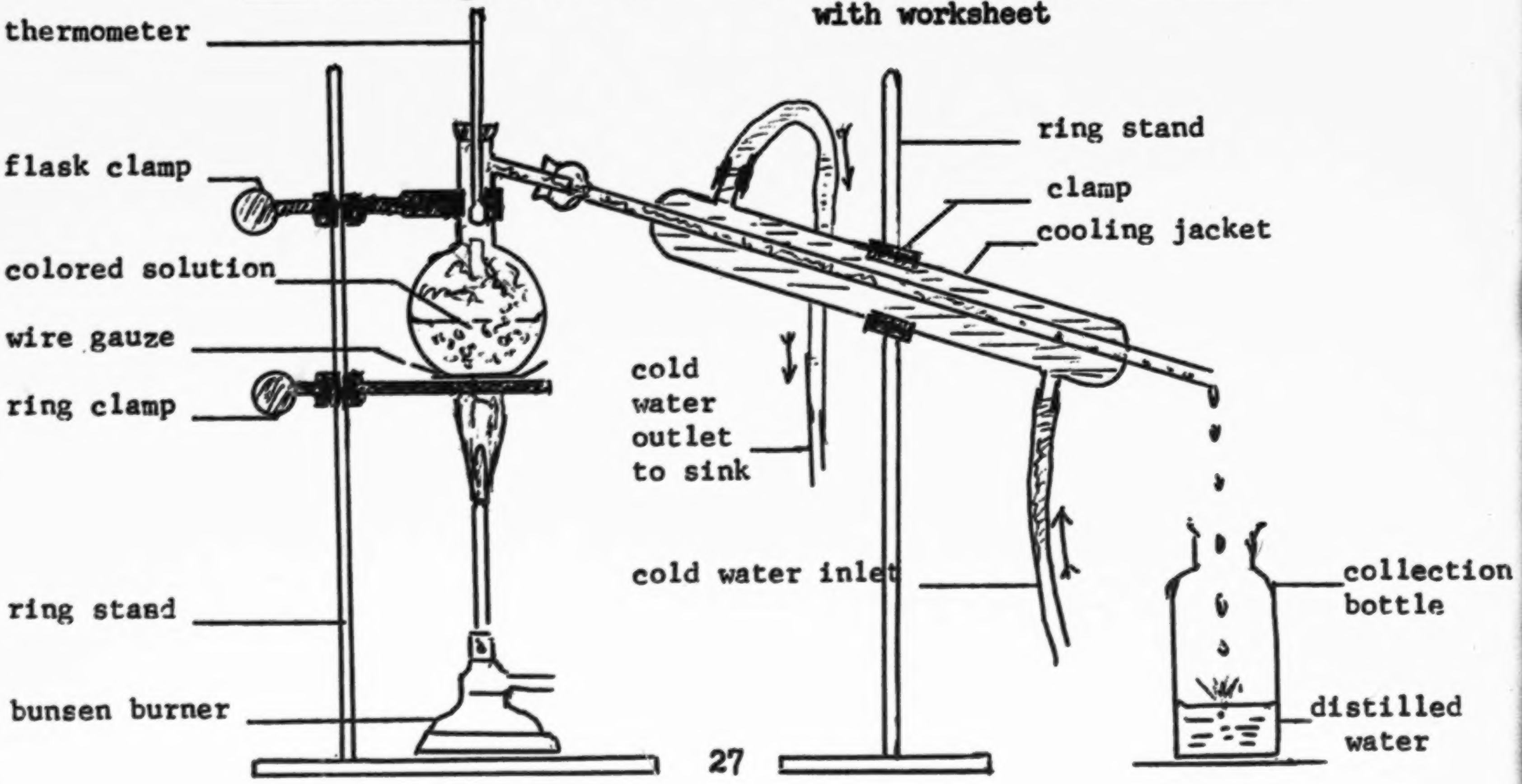
MATERIALS:

Teacher

500 ml flask (side arm)
clamp to fit neck of flask
thermometer inserted into one hole rubber stopper to fit flask
ring stand and ring clamp to support the flask
Liebig condenser , stand, and clamp
collection bottle
copper sulfate solution (or any colored solution)
bunsen burner, alcohol burner, or electric hot plate
labeled diagram

Pupil

unlabeled diagram of distillation apparatus to be distributed with worksheet


thermometer
flask clamp
colored solution
wire gauze
ring clamp
ring stasd
bunsen burner
cold water outlet to sink
cold water inlet
ring stand
clamp
cooling jacket
collection bottle
distilled water

PROCEDURE:

1. Motivate the lesson by displaying a solution of copper sulfate or other colored solution and pouring it into the flask. Elicit, "How can we get the water out of the colored solution?"

2. Review the lesson on evaporation and the recovery of the solute from a solution.

3. Have the pupils note how the condensing tube is made. Ask, "Why are there two tubes here? (One inside of the other). Why is cold water flowing through the jacket?

4. Perform the distillation of the solution as shown in the diagram. Have the pupils note the temperature at which the water begins to boil. (Maintain a slow boil).

   Caution: Be sure to start the flow of cold water in the condensing tube before the boiling of the solution. This is to prevent the cracking of the condensing tube.

   Collect enough distilled water as time will allow.

5. Guide the pupils through the steps - boiling, vaporizing, cooling, and condensing. Elicit, "Is there any difference between the color of the solution in the boiling flask and the color of the distilled water."

SUMMARY:

1. Heating a solution to boiling point changes the liquid to a vapor.
2. Cooling the vapors changes the vapors back to a liquid. This is called condensation.
3. Distillation is a process in which the vapors of a solution are cooled and then collected in a separate container.
4. The collected liquid is a pure form of the liquid solvent and is called the distillate.

HOMEWORK:

Have the pupils complete the assignment on the worksheet.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

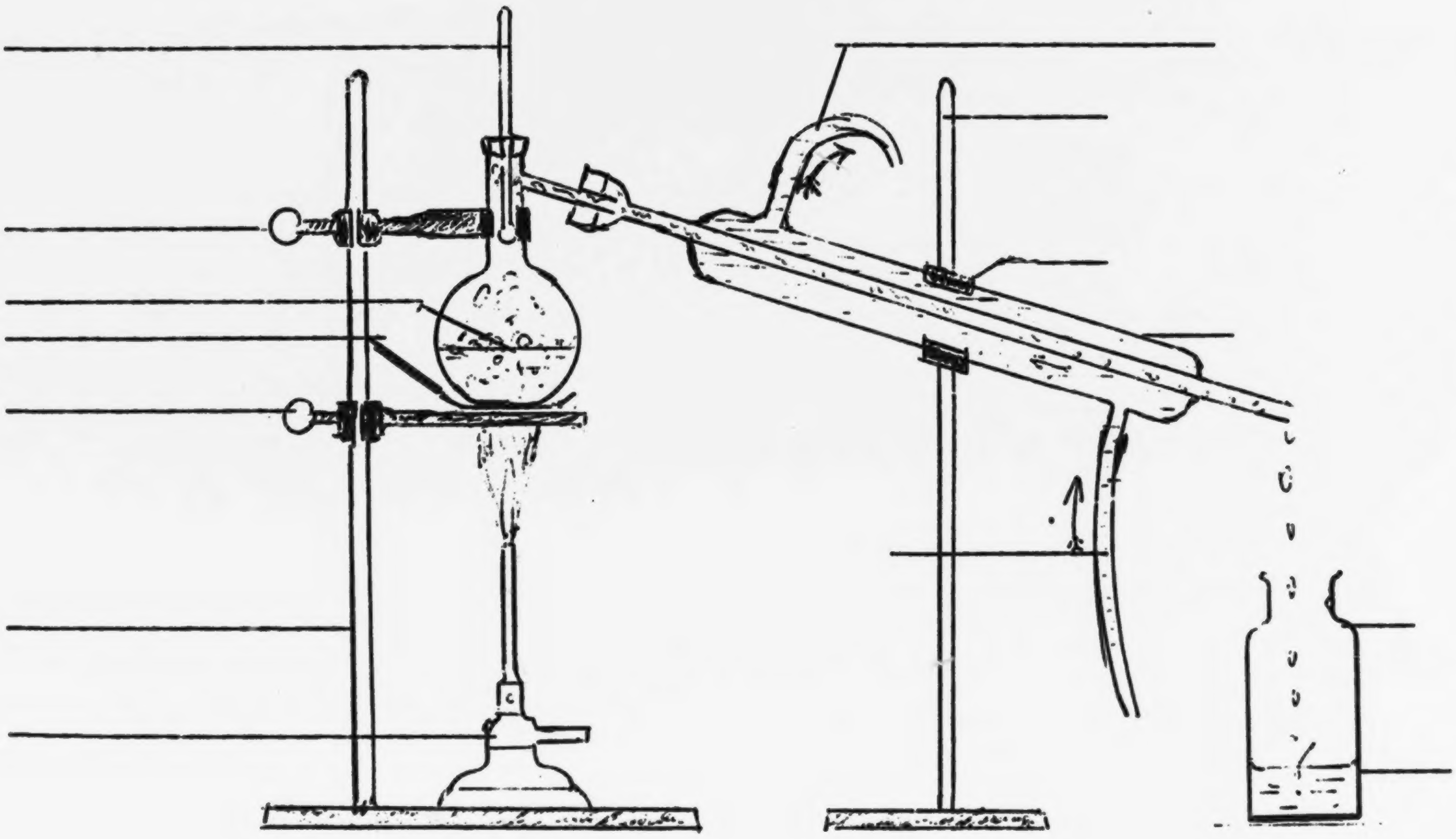
LESSON 9. How can we separate the water from a solution?

MATERIAL:

unlabeled diagram of distillation apparatus

PROCEDURE:

1. Label the parts of the distillation apparatus as instructed by your teacher.



2. Complete the following sentences by putting the correct word in spaces below. (Use the following words to find your answer.)

liquid
distilled
cooled
different
solution
original
vapors
salts

Distillation is the boiling of a ____________to produce__________.

The vapors are ____________in the condensing tube, and are changed back to a ___________form. In this demonstration the condensed vapors are changed into ____________water. The distilled water contains no ____________. Distilled water is completely ______________ from the ______________ solution.

C. HOW CAN THE PARTS OF A SOLUTION BE SEPARATED?

LESSON 10. How can sea water be made safe to drink?

OUTCOMES:

1. In distillation water boils off leaving the dissolved solid behind.
2. The vapors of steam formed are condensed by cooling.
3. Water, which is separated from the solution in this manner, is called distilled water.
4. Distilled water is tasteless, and contains no salts.
5. Distilled water is water in its purest form.

MATERIALS:

Teacher

set up model distillation apparatus

Pupil

ring stand and wire gauze
200 ml flask and one hole rubber stopper to fit
warm salt water solution (enough to half fill flask)
delivery tube as shown in the diagram with a ten inch piece of rubber tubing to fit
8 inch test tube
250 ml beaker of cold water or cracked ice
alcohol burner

PROCEDURE:

1. Motivate the lesson by having the pupils recall how they recovered the salt by evaporation.

2. Ask pupils to explain why filtering could not be used to separate a dissolved salt.

3. From their previous experiment, ask pupils to explain in their own words how distillation could be used to make water safe to drink. Relate this to how lifeboats are equipped with a simple device to "change" sea water.

4. Review the steps in the distillation of impure water. Ask,"Why do we use ice or very cold water?" Elicit that the water vapor or steam must be condensed.

5. Tell the pupils that they are going to use a simple apparatus to do a distillation of water.

6. At the end of the activity, encourage pupils to taste the distillate (by dipping their fingers into the pure water) and noting their reaction to the taste.

SUMMARY:

1. In distillation the liquid part of the solution boils at a lower temperature than the solid part of the solution.
2. The vapors formed can be cooled and collected in a separate container.
3. The collected liquid is called the distillate.
4. Distilled water is water in its purest form.
5. When sea water is distilled, the salt is left behind in the flask and the vapors are cooled, condensed and collected in a separate container. The collected liquid is called distilled water and is safe to drink. It has however no taste because no salts or air is present in distilled water.

HOMEWORK:

Have pupils complete the assignment on the worksheet.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 10. How can sea water be made safe to drink?

MATERIALS:

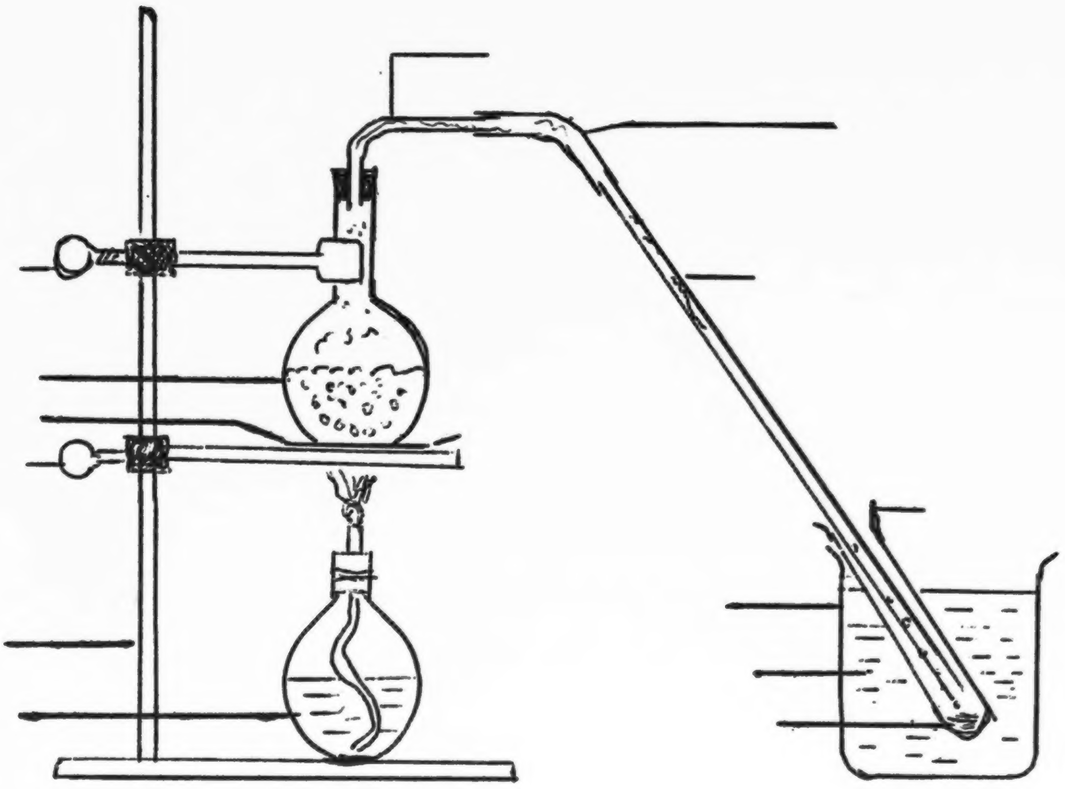
200 ml flask 1/5 full of warm salt water (about 25 to 30 ml)
one hole stopper to fit
right angle glass tubing to fit stopper hole about 3 inches long
glass delivery tube about 1 foot long
3 inch piece of rubber tubing to fit the glass tubing
8 inch test tube
250 ml beaker 1/2 full of cold water or cracked ice
alcohol burner

PROCEDURE:

1. Set up the apparatus as shown in the diagram. (Your teacher will help you do this.)

2. Label the parts from the list below.

clamp
wire gauze
test tube
distillate
ring clamp
alcohol burner
delivery tube
ring stand
flask of salt water
beaker of cold water



3. Boil the sea water in the flask. Observe what comes through the tube. What happens to the steam as it comes into the test tube standing in the ice or cold water?

QUESTIONS:

Fill in the blanks in the following paragraph with words from the list below.

tasteless
liquid
boiling
water drops
flask
pure
condensation
boils
vapor
lower
impurities

To make sea water safe to drink, the mixture is heated to __________________. The vapors or the steam pass off and are cooled back into a ________________. The changing of a vapor back into a liquid is called ___________. The vapor coming out of the delivery tube is __________ water. The salt and other ______________ in sea water are left behind in the ______________ in which the sea water was boiled. Distilled water is ___________ because there are no dissolved salts or air in it.

D. WHAT OTHER TYPES OF MIXTURES ARE THERE?

LESSON 11. Do all things dissolve?

OUTCOMES:

1. Not all solids dissolve to form a solution.
2. A mixture of a liquid and a solid which did not dissolve is called a suspension.
3. Suspensions are cloudy because of the undissolved particles.
4. Particles in a suspension can easily be seen when a beam of light is passed through it.
5. Large particles may soon settle to the bottom.

MATERIALS:

Teacher

2 large graduate cylinders each containing the same amount of water
salt
clay powder
flash light or projector light source

Pupil

test tube containing sugar
test tube containing sand
cork stoppers to fit
test tube rack

PROCEDURE:

1. Add the salt to the water in one cylinder, and the clay to the water in the other cylinder. Shake both. Call the pupils' attention to the two cylinders. Encourage them to describe the differences between the two samples. List their suggestions on the chalkboard in two columns. Identify one column as a solution and the other column as a suspension. Commend those who suggest that the solid did not appear to have dissolved in the suspensions.

2. Tell them that in today's investigation, they will find out how scientists use other methods to show the differences.

3. Distribute the materials and pupil worksheets to small groups of pupils. Help them read and follow the instructions.

SUMMARY:

Review the findings of the pupil investigations. Complete the columns, previously started on the chalkboard, by noting additional differences.

HOMEWORK:

1. Check things around your home. Copy the label of things you think is a suspension.
   Hint: Milk of magnesia is a suspension.
2. Why do you think some medicine labels say, "SHAKE WELL BEFORE USING"?
3. List the differences between a suspension and a solution.

SUSPENSION	**SOLUTION**

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 11. How do we know a suspension when we see one?

MATERIALS:

1 test tube containing sugar
1 test tube containing sand
cork stoppers to fit
light source (flashlight or projector light on teacher's desk)

PROCEDURE:

1. Add water to each test tube and put on the cork stoppers. Shake each test tube for a few seconds. Be careful not to break the test tubes. Look at the test tubes.

   a. The test tube containing ________________ is clear.

   b. The test tube containing ________________ is cloudy.

2. Put the test tubes back on the test tube rack and let stand for a short time.

   a. The sugar (did, did not) ______________ settle to the bottom.

   b. The sand (did, did not) _______________ settle to the bottom.

3. Go up to the teacher's desk and use the flashlight or projector to shine a light at both test tubes. In your own words, explain how the light looks different in the sand and water as compared to the sugar and water.

   ____

   ____

   ____

   ____

4. Answer the following questions:

   a. Why was one of the test tubes cloudy?

   b. Which test tube showed settling of the solid? Why did it settle?

   c. Why did we use a light to find out which one was a suspension and which one was a solution?

   d. Which one could be separated from the water by filtering? Why?

PROPERTIES OF MIXTURES

D. WHAT OTHER TYPES OF MIXTURES ARE THERE?

LESSON 12. What are other methods of removing suspended particles from a water mixture?

OUTCOMES:

1. Particles of suspended matter can be removed from a water mixture by waiting for them to settle out to the bottom. This is called settling (Sedimentation).
2. Heavier particles settle out faster, lighter particles take a longer time to settle out.
3. Lighter particles can be treated with chemicals which cause the lighter particles to come together in clumps. The clumped particles are now heavier and speed up the settling out process. This process is called Coagulation.

MATERIALS:

Teacher

two 500 ml graduate cylinders 3/4 full of water
samples of soil and clay
quantity of water made alkaline to be distributed to the pupils
(This is prepared in advance by adding 5 ml of concentrated ammonium hydroxide to a liter of water.)

Pupil

test tube rack
vial of clay
supply of alkaline water (to be distributed by the teacher)

PROCEDURE:

1. Motivate the lesson by showing the two graduate cylinders, one mixed with soil and the other mixed with clay. Shake both and allow to stand. Elicit which of these mixtures seems to settle faster. Ask, "Why does one of these mixtures seem to settle faster than the other?" Guide the pupils to conclude that the larger, heavier particles settle faster.

2. Ask, "How could the lighter particles be made to settle faster?"

3. Tell the pupils that in today's lesson they are going to use a chemical that will make the lighter particles settle out faster. Relate this to the way in which New York City would use this method as a step in purifying its water supply

4. Distribute the worksheets and materials to groups of pupils. Help them follow the steps of the procedure by aiding them in reading the instructions.

SUMMARY:

1. Suspended particles in a water mixture can be separated by allowing the mixture to stand so that the heavier particles can settle.
2. Heavier particles settle faster, the lighter particles take a much longer time. This is called SEDIMENTATION.
3. When chemicals such as alum are added to the water mixtures, the lighter particles clump together, become heavier, and sink to the bottom faster. This process is called COAGULATION.
4. Reinforce the new terms developed in this lesson.

HOMEWORK:

Have pupils complete the fill-in sentences on the worksheets.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 12. How can we make things settle faster?

MATERIALS:

test tube rack with two 8" test tubes and rubber stopper to fit
supply of tap water
supply of alkaline water
vial of clay

PROCEDURE:

Where does your water supply come from? How does your city get enough water to supply about 8 million people? How can the city clean (purify) the water and make it safe for so many people? Many of you already know that New York City gets its water supply from places more than 150 miles away. The water is stored in man-made lakes called resevoirs. To make the water safe to drink, the city must do many things to remove solids, suspended (not dissolved) particles, and germs. One of the first steps the city takes is to remove solids such as dirt, clay, and bits of other things suspended in the water. It would take too long to wait for the suspended things to settle by themselves. In this lesson, you will see how we can make small bits of suspended things settle faster.

1. Fill one test tube 3/4 full of tap water, add the vial of clay, stopper it and shake well. Replace the test tube in the rack and allow it to stand.

2. Fill a second test tube about 3/4 full of tap water, add a small amount of alkaline water, and some alum. Stopper and shake. Replace in the rack and compare the speed of settling in each of the test tubes.

Ideas you learned from this lesson:

Complete the following by filling the blank spaces with the words in the vocabulary below to make each sentence a true statement.

alum chemicals coagulation clump

faster heavier sedimentation settle

particles

1. Particles of ________________ matter can be separated from a water mixture by waiting for them to settle.

2. The settling out process is called ________________.

3. In sedimentation the ________________ particles settle first.

4. Lighter ____________________ can be made to settle faster by using ________________.

5. The chemical used to speed up settling is called ________________.

6. Alum causes the lighter particles to collect in ________________.

7. The clumping makes the lighter particles heavier and they settle faster.

New vocabulary words to remember:

sedimentation
coagulation
resevoir
clumping
alum

D. WHAT OTHER TYPES OF MIXTURES ARE THERE?

LESSON 13. How can we recognize a colloid?

OUTCOMES:

1. A special type of suspension , called a colloid, is one whose particles are so small that they hardly settle even after long standing.
2. Even though the mixture may look clear, a beam of light when passed through the mixture will be reflected by the colloid particles.
3. Particles of a colloid suspension are so small that they can pass through a filter paper.

MATERIALS:

Teacher

projection lamp
bottles of india ink, mucilage
three 500 ml. flasks each containing a 10:1 mixture of the above
(Note: Use water to make each mixture ten to one.)
ring stands and ring clamps to hold the flasks

Pupil

test tube rack - 4 eight inch test tubes
supply of dilute acetic acid or vinegar (acid to be prepared in advance)
ring stand - ring clamp
funnel - filter paper to fit
500 ml. beaker $\frac{1}{2}$ full of water
medicine dropper
250 ml. beaker
100 ml. graduate cylinder

PROCEDURE:

1. **Motivate the lesson by having the pupils observe the bottles of diluted india ink and mucilage. Have the pupils recall some of the properties identified with a solution (no settling of suspended particles, appears to be clear, will pass through a filter, does not reflect light). Ask if they now think that those flasks contain a solution or a suspension.**

2. To show that a colloid (a special type of suspension)will reflect a beam of light, shine a light (flashlight or projector light) through each mixture. Elicit pupil reactions to what they see.

3. Tell pupils that they are going to learn more about a colloid to see whether it fits into the class of solutions or suspensions.

SUMMARY:

1. Colloids are a special type of suspension whose particles are so small that they hardly ever settle out even on long standing.
2. Colloids may look clear, but when a beam of light is passed through them the colloid particles are large enough to reflect a beam of light.
3. Colloid particles are small enough to pass through a filter paper.
4. Colloid particles are of a size which is larger than those in a solution but smaller than those in an ordinary suspension.

HOMEWORK:

Have the pupils complete the assignment at the end of the worksheet.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

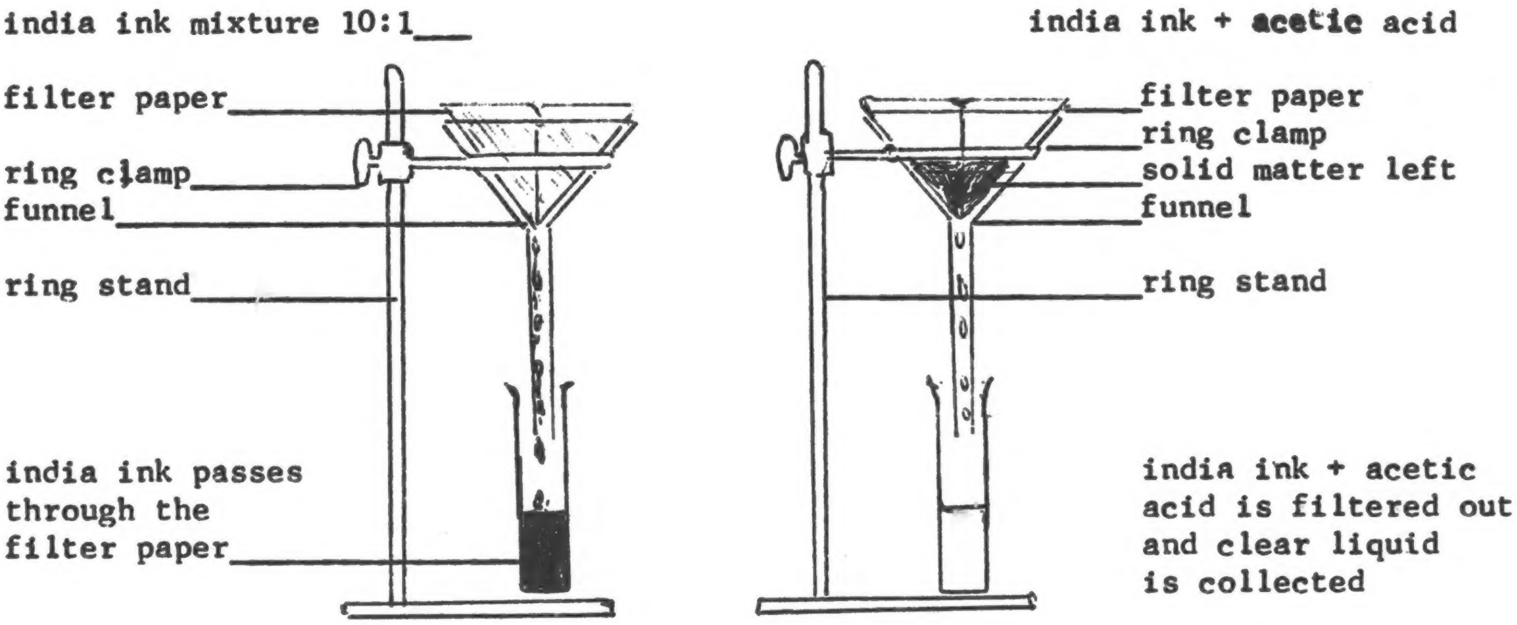
LESSON 13. How can we know a colloid?

MATERIALS:

test tube rack - 4 eight inch test tubes
ring stand - ring clamp
funnel and filter paper to fit
500 ml. beaker half full of water - a supply of dilute acetic acid
supply of india ink
medicine dropper
100 ml. graduate cylinder
250 ml. beaker

PROCEDURE:

1. Assemble the ring stand and clamp as shown in the diagram with the tip of the funnel resting in the test tube.


india ink mixture 10:1
filter paper
ring clamp
funnel
ring stand
india ink passes through the filter paper
india ink + acetic acid
filter paper
ring clamp
solid matter left
funnel
ring stand
india ink + acetic acid is filtered out and clear liquid is collected

2. Make a dilute mixture of the india ink and water by mixing 10 ml. of india ink with 100 ml. of water. Put into the 250 ml. beaker for later use.

3. Try to filter the dilute mixture through a filter paper. Carefully note whether there is any solid material left on the filter paper. Is the color of the mixture in the test tube lighter than, darker than, or the same as before it was filtered?

4. Make another dilute mixture of india ink as in step # 2. With your medicine dropper add about a dropper full of dilute acetic acid to the india ink mixture, and stir gently.

5. Try filtering this mixture through a clean filter paper. Observe the result. Is the color of the filtered liquid lighter than, darker than, or the same as before it was filtered? Is there any solid material left on the filter paper?

QUESTIONS:

From what you did and saw in this laboratory lesson on colloids answer the following questions by filling in the blank spaces with words from the vocabulary below to make a true statement.

smaller
filter paper
larger
colloid
clump
acid
reflect

1. A special type of suspension whose particles hardly ever settle out is called a ____________________.

2. Particles of a colloid are so small they can pass through a ________________.

3. Colloidal particles are large enough to ______________ a beam of light.

4. Colloid particles can be separated from a water mixture by adding a ____________________.

5. The colloid particles separate out because they _______________ together.

6. When a colloid mixture has beem made to clump together the colloid particles become too large to pass through a ___________________.

7. The results seen in this laboratory lesson showed that colloid particles are (larger, smaller) ______________than those in a solution but (larger, smaller) _____________ than those in an ordinary suspension.

Look around your home and see how many colloid suspensions you can find. (Hint - mayonnaise)

D. WHAT OTHER TYPES OF MIXTURES ARE THERE?

LESSON 14. How can oil and water be made to mix?

OUTCOMES:

1. When oil and water are shaken up, they remain mixed only for a short time. They are called immiscible liquids, or non-mixing liquids.
2. When certain substances are added to non-mixing liquids they can be made to mix and will not separate into distinct layers again.
3. The non-separating mixtures are now called Emulsions.
4. The material added to liquids that causes them to remain mixed is called the Emulsifying Agent.

The teacher can refer to the following substances found in the home that are classified as emulsions such as; mayonnaise, catsups, some tomato juices, and homogenized milk. In homogenized milk, the proteins act as the emulsifying agent by preventing the butter fat (oil) and the skim milk (water) from separating. In mayonnaise the egg yolks do a similar job.

MATERIALS:

Teacher

jars of mayonnaise, Italian dressing, and French dressing (these may be borrowed from the home economics department)

Pupil

test tube rack
two eight inch test tubes and rubber stoppers to fit
medicine dropper bottle of soap solution
supply of kerosene
100 ml. graduate
250 ml. beaker full of water

PROCEDURE:

Motivate the lesson by displaying the Italian dressing, French dressing, and the mayonnaise. Review the properties of solutions, suspensions, and colloids. Discuss these properties as they might be applied to the display materials. Read the labels to show the contents of the salad dressings. Stress the water, oil, and vinegar in each of the dressings. In the mayonnaise, stress that the eggs are very important. Have the pupils note the separate layers of liquids in the salad dressings. Read the label part that says, "shake well before using". Elicit the need for shaking.

Shake well and allow to stand. Have pupils note the time for the liquids to return to separate layers or non-mixed condition. Elicit,"Why do these liquids return to separate layers?" Tell pupils that in today's lesson they are going to make oil water mix by adding a substance called an emulsifying agent.

SUMMARY:

1. Oil and water can be made to mix temporarily by shaking them vigorously together, but they will separate into two different layers in a short time.
2. When certain substances are added to a mixture of oil and water, the separation into different layers is prevented. These substances are called emulsifying agents.
3. The new mixture is called an emulsion.

HOMEWORK:

Have pupils complete the assignment at the end of the worksheet.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 14. How can oil and water be made to mix?

MATERIALS:

test tube rack
two eight inch test tubes
medicine dropper bottle of soap solution
a 50 ml. supply of kerosense in a 100 ml. beaker
100 ml. graduate
250 ml. beaker half full of water

PROCEDURE:

1. Into a clean 8" test tube measure 50 ml. of water, add 20 ml. of kerosense, cap with the rubber stopper and shake vigorously about 5 seconds. Observe and answer the following questions.

   a. Are the two liquids easily recognized?
   b. After standing for a short time,see if the liquids begin to separate. Which liquid is on top? Which liquid is on bottom?
   c. From what you saw, tell whether oil and water can be made to mix.

2. To a second clean test tube measure 50 ml. of water and add 20 ml. of kerosense. Now add about 20 drops of soap solution and shake well for about 10 seconds. Allow to stand and observe.

   a. Can you see that there are two separate layers of liquids?
   b. Did the liquids separate into two distinct layers even after standing some time?

HOMEWORK QUESTIONS:

Cross out the incorrect words in parenthesis so as to make each statement a true one.

1. Oil and water are liquids which (do) (do not) mix when put together.

2. To make oil and water mix we must add (more oil) (more water) (an emulsifying agent).

3. When oil, water, and an emulsifying agent are mixed together they form (a suspension)(a colloid)(an emulsion).

4. The emulsifying agent, soap in this experiment, surrounds each oil droplet and (allows the oil droplets to collect and become larger) (prevents the oil droplets from joining together) and thus forms what is called an emulsion.

D. WHAT OTHER TYPES OF MIXTURES ARE THERE?

LESSON 15. How do soaps differ from detergents in cleansing properties?

OUTCOMES:

1. New surface cleaners called "detergents" now in use are more effective than soaps in cleansing.
2. The detergents "wet" materials more easily and more readily than soaps.
3. Detergents lather more readily and more thoroughly than soaps in all types of water, even salty ocean water or chemically hard-water.
4. Detergents form an emulsion of oils, greases, and dirt very quickly. These emulsions are rinsed easily and quickly in the washing process.

MATERIALS:

Teacher

liquid soap solution
containers of liquid detergents such as "ALL", "LIQUID LUX"
4 cotton batting balls (small)
1000 ml. beaker or battery jar of cold tap water
1000 ml. beaker or battery jar of cold concentrated salt water
four 500 ml. graduates

Pupil

test tube rack
four 8" test tubes and rubber stoppers to fit
medicine dropper bottle of liquid soap
medicine dropper bottle of liquid detergent
500 ml. beaker of cold tap water
500 ml. beaker cold salt water (concentrated)
100 ml. beaker half full of kerosene
100 ml. graduate

PROCEDURE:

1. Display various liquid detergents and liquid soaps. Explain to pupils that for over 150 years the only cleaning agent that was used for washing and laundering was soap made from animal fats cooked with lye. Elicit from their previous lesson, that soaps form an emulsion with dirt and greases which are rinsed away in laundering.

2. Suggest answers to the question, "Can we use soap to bathe at the beach?" Elicit the difficulty in trying to get a good lather.

2

3. Label the graduates #1, #2, #3, #4. Add the following to each:

    a. to #1 add 500 ml. cold water, and 10 ml. soap solution
    b. to #2 add 500 ml. salt water, and 10 ml. soap solution
    c. to #3 add 500 ml. cold water, and 10 ml. detergent
    d. to #4 add 500 ml. salt water, and 10 ml. detergent

4. Place a cotton ball in each graduate and have pupils note which cotton ball sinks first. Elicit from the pupils why the cotton ball in the detergent sank first. Develop the idea that the detergent wets faster than the soap.

SUMMARY:

Based on your demonstrations and the pupil investigations conclude that:

1. Detergents wet materials faster than ordinary soaps, even in salt water.
2. Detergents lather better than ordinary soap, even in salt water.
3. Detergents form emulsions of greases or oils faster than soaps even in salt water.

HOMEWORK:

Have pupils complete the assignment on the worksheet.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 15. How do soaps differ from detergents in cleaning properties?

MATERIALS:

four 8" test tubes in test rack
medicine dropper bottle of liquid soap
medicine dropper bottle of liquid detergent (ALL or LUX)
100 ml. graduate
500 ml. beaker of tap water (half full)
500 ml. beaker of cold salt water (half full)
50 ml. of kerosene

PROCEDURE:

1. Measure into a clean test tube 50 ml. of cold tap water, add 10 ml. of kerosene, add 10 drops of liquid soap solution, stopper and give about 10 hard shakes. Note the amount of suds made.

2. Measure into a clean test tube 50 ml. of cold salt water, add 10 ml. of kerosene, add 10 drops of soap solution, stopper and shake well. Compare the suds formed against those in step #1. Which formed more suds, step #1 or step #2?

3. Repeat as in step #1 only this time use cold salt water, 50 ml. of kerosene, add 10 drops of soap, stopper and shake 10 times. Compare with steps #1 and #2. Which made more suds?

4. Repeat as in step #1, this time use cold salt water, 10 drops of detergent, stopper and shake 10 times. Compare with steps #1, #2, and #3. Which formed the most suds?

HOMEWORK QUESTIONS:

Cross out the incorrect words in parenthesis to make each statement a true one.

1. Ten drops of soap solution in a 50 ml. mixture of kerosene and water made (more) (less) suds than ten drops of detergent in a similar mixture of kerosene and water.

2. Ten drops of soap in a 50 ml. mixture of kerosene and salt water made (more) (less) than ten drops of detergent in a similar mixture of kerosene and water.

3. From what you saw and did, tell whether soaps or detergents are (better) (not as good) for making emulsions of dirt and grease.

4. Soaps (leave) (do not leave) a film that is hard to rinse out.

PROPERTIES OF MIXTURES

D. WHAT OTHER TYPES OF MIXTURES ARE THERE?

LESSON 16. Why do we homogenize milk?

OUTCOMES:

1. The total fat content of homogenized milk is the same as in plain milk.
2. In plain milk the butter fat particles are large, tend to clump together and float to the top of the milk in a short time. The bottom layer is "Whey" or water.
3. Homogenized means equally distributed throughout. When milk is homogenized the fat particles are made so tiny that they remain evenly distributed throughout the milk and form an emulsion.

Note - If plain milk is not easily obtainable, a substitude can be made by filling an ice cube tray three quarters full with homogenized milk freezing in the refrigerator and then allowing to thaw out. The milk will now separate into two distinct layers and be similar to plain milk.

MATERIALS:

Teacher

glass containers of homogenized milk and plain milk, or substitute milk

slide projector to be used as a strong source of light

Pupil

microscope
2 glass slides - 2 cover slips
medicine dropper
paper towel (to be used for cleaning slides)

PROCEDURE:

1. Have pupils recall the properties of suspensions and emulsions.

2. Tell them that you are going to pass a beam of light through the containers of homogenized milk and then through the plain milk, or the substitute. Elicit that there are no distinct layers in the homogenized milk, but that the plain milk shows two distinct layers. The cream is on top and the water part below.

3. Tell the pupils that although plain milk and homogenized milk have the same butter fat content and the same food value, homogenized milk costs about two cents more a quart because of the special process to convert plain to homogenized milk.

4. Explain that when homogenized milk is made, it is forced under very high pressure through a metal plate with many tiny holes. These holes are so small that without pressure water will not flow through them. The passage of the milk through these holes breaks up the butterfat into the small round globules seen under the microscope. In today's experiment, pupils will study homogenized milk under a microscope to observe the tiny fat particles.

SUMMARY:

1. In plain milk the fat particles clump together and form a layer of fat which floats on top.
2. In homogenized milk the fat particles are so small that they remain suspended making this type of milk an emulsion.
3. Homogenized means equally suspended throughout.

HOMEWORK:

Have pupils complete the assignment on the worksheet.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 16. How is homogenized milk different from plain milk?

MATERIALS:

microscope
2 glass slides - 2 cover slips
medicine dropper
supply of homogenized milk and plain milk (or converted homogenized milk)
paper towel

PROCEDURE:

1. Set up your microscope for viewing under low power. Adjust your mirror so that you get the most light. Now place a drop of homogenized milk on your slide with the medicine dropper. Place the cover slip on top so as to spread the milk. Focus under low power and find any drops of fat. Note the size. If you do not see any drops of butter fat, turn to high power. Note the size and number of fat particles to be seen.

2. Repeat the same steps with plain milk and make a comparision drawing of the size of butter fat droplets in homogenized milk and plain milk.

HOMEWORK:

Based on the teacher demonstration and what you did in the laboratory answer the questions by crossing out the incorrect words in parenthesis to make each statement a true one.

1. The fat particles in homogenized milk are (larger) (smaller) than those in plain milk.

2. In order to make a temporary emulsion of plain milk it should be (kept cold) (shaken vigorously).

3. Homogenized milk has the fat particles (equally) (unequally) distributed throughout the milk.

4. Homogenized milk is an example of a (suspension) (emulsion).

D. WHAT OTHER TYPES OF MIXTURES ARE THERE?

LESSON 17. What is an explosive mixture of gasoline and air?

OUTCOMES:

1. Liquid gasoline will burn with a smoky flame.
2. Vaporized gasoline burns very rapidly.
3. When the proper ratio of gasoline vapor and air is reached, an explosive mixture is obtained. This mixture when ignited will burn with explosive force.

SAFETY PRECAUTIONS:

1. Be sure to put the evaporating dish into the sand container when demonstrating the burning gasoline. Use the asbestos board to put out the flames.

2. Be sure to cap the gasoline container after each use. Remove gasoline away from demonstration area.

3. Be sure to extinguish all flames when not using them in the demonstration.

4. Move pupils away from the demonstration table.

5. The friction -lid can should be about one pint in size for you to use 4-5 drops of gasoline. If you use a quart size can, you may have to use up to 10 drops to get an explosive mixture. A smaller can is more desirable.

MATERIALS:

TO BE DONE BY THE TEACHER ONLY!

NOTE: It is suggested that you try out the demonstration before hand so that you will be aware of safety problems.

atomizer bottle
alcohol lamp or candle
evaporating dish
supply of gasoline
can with a friction lid (Cut a small hole ($\frac{1}{4}$") on the side near the bottom.)
wax taper or safety matches
wash basin half full of sand
asbestos pad as a cover for the evaporating dish
medicine dropper

PROCEDURE:

1. Distribute the worksheets and have pupils complete or fill in the answers during the demonstration.

2. Place the evaporating dish in the sand of the basin. Pour about 15 ml. of gasoline into the evaporating dish. Motivate the lesson by asking, "Does gasoline burn?"

3. Light the gasoline and have the pupils note the smoky flame. Ask, "Was there any explosion when the gasoline was ignited?" Tell them to remember this fact for reference later on. (Cover the flame with the asbestos board to put out the flame.)

4. Put some gasoline in the atomizer bottle. Spray some gasoline into the air. Elicit that the liquid gasoline has now become a vapor. Light the alcohol lamp and spray some gasoline vapors from the atomizer into the flame of the alcohol lamp. Have the pupils note the speed with which the gasoline now burns. Elicit, "Why does the gasoline now burn so much faster than when it was burning in the evaporating dish?" Bring out that more surface was exposed to the air for the burning in the vapor state than in the liquid state.

5. Remove the lid from the friction can and put about 4 or 5 drops of gasoline into the can. Replace the lid and wait for about a half minute for the gasoline to evaporate.
(CAUTION: HAVE THE PUPILS AT A SAFE DISTANCE FROM THE DEMONSTATION.)
Now light the wax taper and place the lighted end into the hole in the bottom of the can. (The explosive force of the burning gasoline will lift the lid almost to the ceiling.)

6. Now have them recall what happened when the gasoline was burning in the evaporating dish. Ask, "Was there an explosion?" Elicit, that in the can there were only 4 or 5 drops of gasoline and yet when ignited there was a strong explosion.

7. Explain that an explosion occurs only when the mixture of air and (fuel) gasoline are mixed in the right amounts or proportions. In the gasoline engine, the proportions are about one volume of gasoline vapor to about 9000 volumes of air in order to get the full power out of the rapidly burning or exploding gasoline vapors.

8. Relate the rapid burning or explosive force of the gasoline vapors to the operation of a gasoline engine or automobile engine. Point out that you cannot put more gasoline into the cylinders of an automobile engine to make it go faster since this only causes the flooding of the cylinders with gasoline. The engine will not start because the gasoline vapor ratio to air has been upset.

SUMMARY:

1. Liquid gasoline burns slowly and with a smoky flame.
2. When liquid gasoline is changed to a vapor form and ignited it burns with greater speed.

3. When gasoline vapors and air are mixed in the right proportions and ignited they will burn with explosive force.
4. When this explosive force is controlled it can be used by man in an engine to do his work.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 17. What is an explosive mixture of gasoline and air?

Cross out the incorrect words to make a true statement in each of the following.

1. When the liquid gasoline in the evaporating dish was ignited it burned (rapidly) (slowly) (with explosive force).
2. The liquid gasoline burned (without a smoky flame) (with a smoky flame).
3. The atomizer made the liquid gasoline into a (solid) (Vapor).
4. When the vaporized gasoline was lit it burned (slower) (faster) (the same) as the liquid gasoline.
5. When lit the vaporized gasoline burned faster because ther was (less) (more) air available for the rapid burning.
6. Gasoline burns faster when it is in the (liquid) (vapor) state.
7. The four or five drops of liquid gasoline in the friction lid can (remained as a liquid) (became a vapor) when left to stand in the can.
8. The vaporized drops of gasoline mixed with the air in the can made a mixture of air and gasoline that was (slow burning)(fast burning) (explosive.)

D. WHAT OTHER TYPES OF MIXTURES ARE THERE?

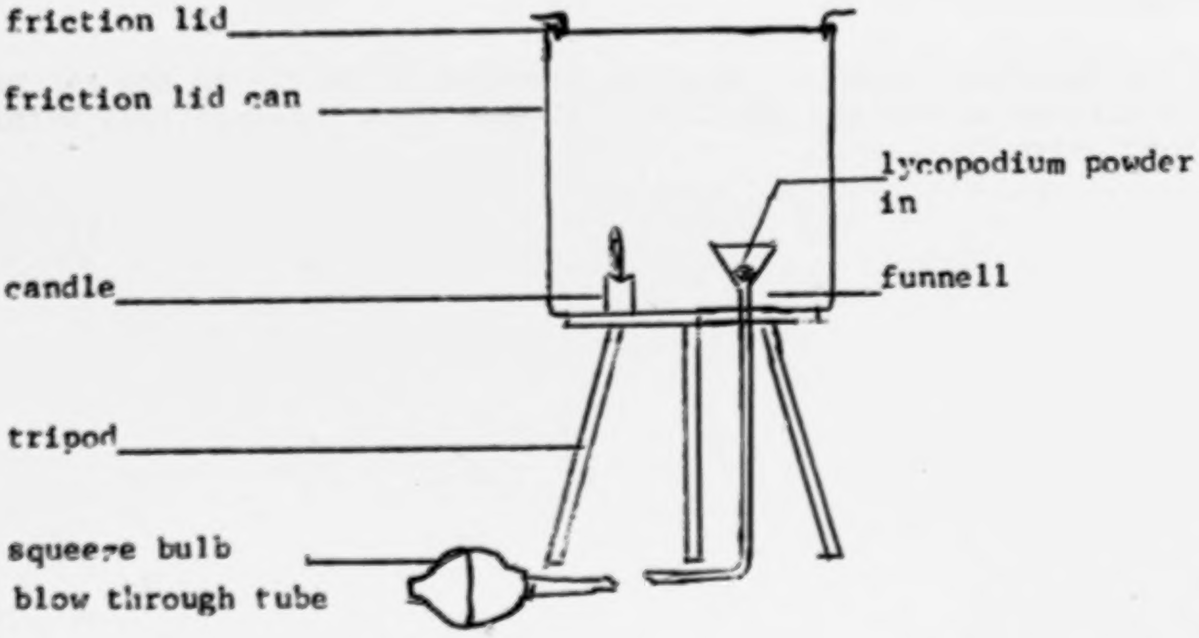
LESSON 18. How can a mixture of dust and air cause an explosion?

OUTCOMES:

1. The smaller the particles of matter exposed to the oxygen of the air the faster the burning reaction.
2. If the same amount of matter is lumped into a small mass as in step #1 the matter will not explode but burn slowly.
3. When the particles size and the proper amount of air are mixed in the right amounts a violent explosion results.

MATERIALS:

friction lid can as in diagram
lycopodium powder
asbestos board
bunsen burner, alcohol lamp or propane torch
candle to fit in can as in diagram
long rubber tube (about six feet long)
small funnel
long glass tube (two feet)


friction lid
friction lid can
lycopodium powder in
funnell
candle
tripod
squeeze bulb
blow through tube

PROCEDURE:

1. Motivate the lesson by asking, "Can dust explode?"

2. Place a small amount of lycopodium powder on the asbestos board. Use the burner to try to start it burning. Have the pupils note that it burns very slowly.

3. Put a small amount of lycopodium powder in the end of the glass tube. Place the end of the tube a few inches from the flame of the burner and gently blow the powder into the flame. Have the pupils note the rapid burning.

4. Place a small piece of paper in the bottom of the funnel which is in the friction can and add about 15 ml of lycopodium powder. Set the can on the tripod as shown in the diagram and place the lighted candle in the bottom of the can. Stand well away from the can, blow into the rubber tube or use a hand pump to raise the dust inside the can. (The dust will ignite instantaneously in the presence of the candle flame. Watch the lid lift off and a huge flame shoot up into the air.

5. Relate the fact that many explosions in coal mines are caused by the coal dust in the air becoming ignited and burning at explosive speed. Many dust explosions in flour mills are the result of the mixture of flour dust and air being ignited.

SUMMARY:

1. If particles of dust are lumped together the dust will only burn slowly if ignited.

2. If the same amount of dust is spread out into the air as was in the lumped mass and ignited it will burn with an explosive force.

3. The size of the particle of matter and the amount of air which surrounds it determine the speed of burning.

4. When the proper mixture of air and dust is reached mix and becomes ignited an explosion will result.

HOMEWORK:

Have the pupils complete the assignment on the worksheet.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 18. How can a mixture of dust and air cause an explosion?

From the demonstration complete the following statements by crossing out the incorrect words or phrases in parenthesis.

1. When the lycopodium powder was placed in a small heap or lump it burned (rapidly) (slowly).
2. When the lycopodium powder was blown out of the glass tube into the flame it burned (at a slower rate) (faster rate) than when it was in a lump.
3. When the lycopodium powder was ignited in the friction lid can it burned (without an explosion) (with an explosion) (didnot burn at all).

Answer the following questions:

1. Give one reason why smoking is forbidden in a coal mine?
2. Why are there explosions in flour mills?

E. HOW DOES WATER CHANGE WHEN IT BECOMES PART OF A SOLUTION?

LESSON 19. Why do some foods taste sour?

OUTCOMES:

1. Many foods contain acids.
2. Acids have certain common characteristics, such as a sour taste.
3. Strong acids react with metals.

MATERIALS:

Teacher Demonstration

one 8" test tube
25 ml. 10% HCL solution
a few pieces of mossy zinc
blue litmus paper
bromthymol blue indicator solution

Pupil Materials

lemon juice
vinegar
seltzer (soda water)
grapefruit juice
eight 6" test tubes and test tube rack
4 pieces of blue litmus paper
one 4" test tube 3/4 full of bromthymol blue indicator solution

PROCEDURE:

1. Motivate the lesson by having pupils recall some foods which have a sour taste. These could include lemons, vinegar, seltzer, and grapefruit. Ask them what makes the sour taste.

2. Demonstrate that strong acids will react with metals. Show that some part of the metal will dissolve and a gas (hydrogen) will be given off. Set up and 8" test tube according to the diagram below. Fill it 3/4 full with a 10% solution of hydrochloric acid (1 part acid and 9 parts water). Add several small pieces of zinc metal.

   Note: Shiny zinc will not work. If zinc is new dip it into a solution of $CuSO_4$ until it is quite dark. Small strips of magnesium may also be used.

3. Pupils should note that a gas (hydrogen) is given off by the "pop" test. Collect pure hydrogen gas in a 4" test tube hung upside down at the end of the delivery tube coming from the 8" test tube.

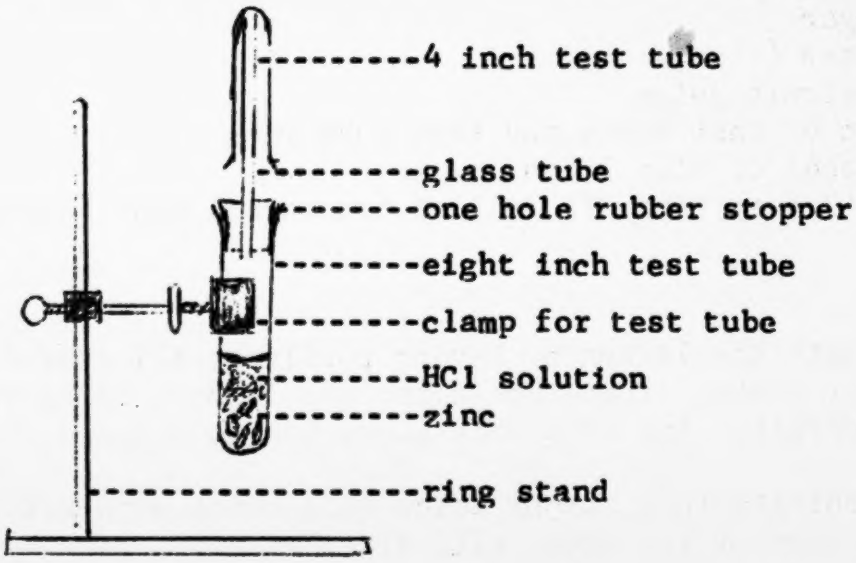
Take about 1 minute for the hydrogen gas to displace all the air in the test tube. Then insert a burning splint. You will hear a "pop". Make sure that the 4" test tube is kept upside down when you insert the splint. Pupils should also note that the appearance of the metal has changed.

4. Show that strong acids affect litmus paper by dipping some blue litmus paper into the acid solution and eliciting the observation that it turned blue to red.

5. Demonstrate that an acid can affect another indicator such as a solution of bromthymol blue. Add a few drops of a concentrated solution of the indicator to a 100ml. beaker half filled with water. The water in the beaker should be green in color. Add some of the acid solution from the 8" test tube and have pupils observe that the solution turns yellow.

6. Explain to pupils that in today's experiment they will test some foods with litmus paper and bromthmol blue indicator solution in order to note whether they have acids in them.

7. Distribute the trays containing the materials listed to groups of pupils. Guide the pupils as to how the experiment will be conducted. Help them read the instructions on the worksheet.



bubbles of gas show that the metal reacts with the acid solution

SUMMARY:

1. Some foods taste sour because they have acids in them.
2. Acids can turn blue litmus paper red and bromthymol blue indicator yellow.
3. Some acids can dissolve some metals.

HOMEWORK:

1. Answer the questions at the end of the laboratory sheet.
2. Give each pupil several strips of litmus paper or bromthymol indicator solution to take home and test different foods (tomatoes, soda water, milk) to see if they are acidic.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 19. Why do some foods taste sour?

MATERIALS

lemon juice vinegar grapegruit juice	Provide enough of each liquid to fill the rounded bottom of three test tubes.

seltzer (enough to fill a 6" test tube half full)
eight 6" test tubes
four pieces of blue litmus paper
one 4" test tube 3/4 full of bromthymol blue indicator solution

PROCEDURE:

In today's experiment you will learn ways to find out whether some foods have acids in them. Show what you see by circling the correct group of words in each of the boxes on the chart.

Test	lemon juice	vinegar	seltzer	grapefruit juice
blue litmus paper	paper turns red paper does not change	paper turns red paper does not change	paper turns red paper does not change	paper turns red paper does not change
bromthymol blue	turns yellow does not change	turns yellow does not change	turns yellow does not change	turns yellow does not change

1. Add enough lemon juice to a 6" test tube so that the rounded bottom is filled. Add enough water so that the test tube is half full. Tip the test tube on its side so that the liquid comes near the mouth. Be careful not to spill it. Dip the blue litmus paper into the solution. Add some bromthymol blue indicator to the test tube. Check the right statement above in the table of tests.

2. Add enough vinegar to a second 6" test tube so that it is half full. Tip the test tube on its side so that the liquid comes near the mouth. Be careful not to spill it. Dip the blue litmus paper into the solution. Add some bromthymol blue indicator to the test tube. Use the table above to show what you saw.

3. Tip the test tube with seltzer on its side so that the liquid comes near its mouth. Be careful not to spill it. Dip the blue litmus paper into the solution. Add some bromthymol blue indicator to the test tube. Use the table above to show what you saw.

4. Add enough grapefruit juice to a 6" test tube so that the rounded bottom is filled. Add enough water so that the test tube is half full. Tip the test tube on its side so that the liquid comes near the mouth. Be careful not to spill it. Dip the blue litmus paper into the solution. Add some bromthymol blue indicator to the test tube. Use the table above to show what you saw.

Fill in the answers to the following questions:

1. Some foods taste ________________ because they have __________ in them.

2. An acid solution can make blue litmus paper turn _______________.

3. Strong acids can dissolve some _______________.

E. HOW DOES WATER CHANGE WHEN IT BECOMES PART OF A SOLUTION?

LESSON 20. Why is soap slippery?

OUTCOMES:

1. Bases turn red litmus paper blue.
2. Bases feel slippery between the fingers.
3. Many household products such as cleaners contain bases.

MATERIALS:

Teacher Demonstration

500 ml. beaker 3/4 full of 1% solium hydroxide solution
(1 gram / 100 ml. of water)
red litmus paper
phenolphthalein solution indicator

Pupil Materials

three 6" test tubes and a test tube rack
household ammonia (diluted 1 to 10 parts of water) - enough to fill ½ of a 6" test tube
windex - enough to fill ½ of a 6" test tube
soap - piece about the size of a pea
phenolphthalein indicator solution - 4" test tube full
red and blue litmus paper

PROCEDURE:

1. Motivate the lesson by showing pupils household ammonia and some other products used to clean windows and other surfaces. Also show them a labeled bottle of lye used to clean drains. Question pupils about these products in order to elicit from them why they are more effective than water.

2. Demonstrate some of the characteristics of a solution of a base. Fill a 500 ml. beaker 3/4 full with a 1% sodium hydroxide solution. Dip some red litmus paper in it and elicit from pupils the observation that the color changes to blue. Add a few drops of phenolphthalein indicator solution and elicit from the pupils the observation that the colorless indicator solution turns red.

3. Call on a pupil volunteer to come to the front of the room and have him dip the tip of his finger in the solution and then rub some of the sodium hydroxide solution between his fingers. Elicit that the liquid feels slippery. Have the pupil rinse his hands thoroughly with tap water.

4. Explain to pupils that in today's experiment they will test some household products to see whether they have the characteristics of a base.

5. Distribute the trays containing the materials listed above to groups of pupils. Guide the pupils as to how the experiment will be conducted. Help them read the instructions on the worksheet.

SUMMARY:

After the experiment is completed by the pupils, have them refer to the chart when you elicit the following:

1. A good test for a base is that it turns red litmus paper blue.
2. Blue litmus paper does not change color.
3. Soap is basic

HOMEWORK:

Give each pupil a few strips of litmus paper and ask them to use it to test some cleaning agents at home. Caution pupils that bases can be dangerous because of their corrosive quality. Have pupils bring in a list of the home products which are basic.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 21. What are some useful bases?

MATERIALS:

three 6" test tubes and a test tube rack
household ammonia solution (diluted 1 part to 10 parts of water)- enough to fill ½ of a 6" test tube
windex - enough to fill ½ of a 6" test tube
soap - piece about the size of a pea
phenolphthalein indicator solution - 4" test tube full
red and blue litmus paper

PROCEDURE:

In today's experiment you will learn ways to find out whether some household products have bases in them. Show what you see by circling the correct group of words in each of the boxes on the chart.

Test	household ammonia	windex	soap
red litmus paper	paper turns blue paper does not change	paper turns blue paper does not change	paper turns blue paper does not change
blue litmus paper	paper turns red paper does not change	paper turns red paper does not change	paper turns red paper does not change
phenolphthalein indicator	paper turns red paper does not change	paper turns red paper does not change	paper turns red paper does not change

1. Fill a 6" test tube half full with household ammonia. Tip the test tube on its side so that the liquid comes near its mouth. Be careful not to spill it. First dip the red, and then the blue litmus paper into the solution. Each time you dip the paper into the solution see whether it changes color. Add a few drops of phenolphthalein indicator solution and see whether it changes color. Draw a circle around the correct words on the table above to show what you saw.

2. Pour enough windex solution into a 6" test tube so that it is half-full. Tip the test tube on its side so that the liquid comes near its mouth. Be careful not to spill it. First dip the red, and then the blue litmus paper into the solution. Each time you dip the paper into the solution see whether it changes color. Add a few drops of phenolphthalein indicator solution and see whether it changes color. Draw a circle around the correct words on the table above to show what you saw.

3. Drop a small piece of soap into a 6" test tube. Add enough water so that the test tube is ½ full. Put a stopper into the test tube and shake it so that the soap dissolves in the water. Tip the test tube on its side so that the liquid comes near the mouth. Be careful not to spill it. First dip the red, and then the blue litmus paper into the solution. See whether the paper changes color. Add a few drops of phenolphthalein indicator solution and see whether it changes color. Draw a circle around the correct words on the table above to show what you saw.

Answer the following questions:

1. A base changes litmus paper from ____________ to ____________.

2. Many good household cleaners have a ______________ in them.

3. A slippery feeling shows that the thing is probably a ________.

E. HOW DOES WATER CHANGE WHEN IT BECOMES PART OF A SOLUTION?

LESSON 21. How can we make an acid neutral?

OUTCOMES:

1. An acid can be mixed with another substance which will change it so that it no longer acts like an acid.
2. When an acid has lost its properties it is said to be neutralized.
3. Stomach powders are sometimes taken to neutralize some stomach acid.

MATERIALS:

Teacher Demonstration

500 ml beaker
4% solution of HCl (add 42 ml. of conc. HCl to 460 ml. water)
blue litmus paper
phenolphthalein indicator solution
100 ml. of a 30% solution of sodium hydroxide

Pupil Materials

phenolphthalein indicator solution
two 150 ml. beakers
100 ml. graduate cylinder with about 60 ml. of vinegar
stirring rod
100 ml. graduate cylinder with about 60 ml. of a 5% sodium carbonate solution
red and blue litmus paper

PROCEDURE:

1. Motivate the lesson by recalling many TV ads which refer to "acid stomach", "heartburn", etc. Elicit pupil reactions to the announcer's suggestions and the terms used (neutralize).

2. Point out that the discomfort was caused by excess stomach acid and that most medicines are chemicals which react with the acid to change it - neutralize it.

3. Demonstrate the neutralization of an acid. Pour 350 ml. of a 4% solution of hydrochloric acid into a 500 ml. beaker. (Make the acid solution by mixing 42 ml. of concentrated hydrochloric acid with 460 ml. of water.) Show that the solution is acidic by dipping some blue litmus paper into it. Pupils should observe that the litmus paper turned red. Recall with pupils from previous experiments that this was a test for an acid. Add a few drops of phenolphthalein indicator solution. Neutralize the acid by slowly adding about 50 ml. of a 30% sodium hydroxide solution. Add the last 10 ml. very slowly.

When the first shade of pink appears, the solution is about neutral. Test it again with blue litmus paper. Pupils will observe that the paper did not turn pink. Develop the concept that the acid is no longer acting like an acid. That is, it has been neutralized.

4. Explain to pupils that in today's experiment they will find out a way to neutralize an acid.

5. Distribute the trays containing the materials listed above to groups of pupils. Guide them as to how the experiment will be conducted. Help them read the instructions on the worksheet.

SUMMARY:

1. When a base is added to an acid, it stops acting like an acid.
2. When an acid loses its properties, we say that it has been neutralized.
3. We can neutralize an acid by mixing it with a base.

HOMEWORK:

Ask pupils to perform an experiment at home in which they neutralize an acid by adding a base to it. Pupils can neutralize seltzer or soda water by adding solium bicarbonate or a commercial antiacid. Distribute red and blue litmus paper so that they can test the solutions.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 22. How can we make an acid neutral?

MATERIALS:

phenolphthalein indicator solution
two 150 ml. beakers
100 ml. graduate cylinder with about 60 ml. of vinegar
stirring rod
100 ml. graduate cylinder with about 60 ml. of a 5% sodium carbonate solution (50 gms. with enough water to make 1000 ml. of solution)
red and blue litmus paper

PROCEDURE:

In today's experiment you will see how vinegar, an acid used to prepare food is changed so that it does not have acid properties.

1. Take an empty 150 ml. beaker and pour about 50 ml. of vinegar into it. Take a strip of blue litmus paper and dip it into the vinegar. The blue litmus turned ______________. This shows that vinegar is an ________________.

2. Add a few drops of phenolphthalein indicator. Mix the vinegar with a stirrer. The solution should still be colorless.

3. Take the 100 ml. graduate cylinder with sodium carbonate solution in it and pour it slowly into the beaker with vinegar. Keep stirring with the stirring rod. Add the sodium bicarbonate solution until the vinegar solution turns pink.

4. Dip a strip of blue litmus paper into the solution. Did the color of the litmus paper change to red? Yes - No _______________

5. Take a strip of red litmus paper and dip it into the sodium carbonate solution by tipping the graduate cylinder on its side. The red litmus paper turned ________________. Add a few drops of phenolphthalein solution. The sodium bicarbonate solution turns __________________. Because the sodium carbonate solution turned red litmus paper blue and phenolphthalein indicator red it must be a _____________________.

Answer the following questions:

1. We know that vinegar is an acid because it turned blue litmus paper ______________.

2. When we added ______________________ solution the vinegar was changed so that it stopped acting like an acid.

3. Sodium carbonate must be a _________________ because it turned red litmus paper blue.

4. You can neutralize an acid by mixing it with a __________________.

E. HOW DOES WATER CHANGE WHEN IT BECOMES PART OF A SOLUTION?

LESSON 22. How can we make a base neutral?

OUTCOMES:

1. A base can be mixed with another substance which will change it so that it no longer acts like a base.
2. When a base has lost its properties it is said to be neutralized.
3. Soap and other household cleaning agents are bases.

MATERIALS:

Teacher Demonstration

500 ml. beaker
250 ml. 4% NaOH solution
250 ml. 4% HCl solution
phenolphthalein indicator solution
red litmus paper
stirring rod

Pupil Materials

250 ml. erlenmeyer flask with 75 ml. of water in it and a rubber stopper
eye dropper with some liquid soap in it
stirring rod
phenolphthalein indicator solution
red litmus paper
125 ml. erlenmeyer flask filled with 100 ml. of a 4% HCl solution
(add 42 ml. of conc. HCl to 460 ml. of water)

PROCEDURE:

1. Recall with pupils from the two previous lessons that an acid was neutralized by using a base. Elicit from pupils specific examples such as using sodium carbonate (a base) to neutralize vinegar (an acid).

2. Review with pupils the methods used to identify acids and bases. Recall with them that phenolphthalein indicator solution was red in a basic solution and colorless in an acid solution. Elicit that red litmus paper changes color to blue in a basic solution.

3. Demonstrate for pupils the neutralization of a base. Pour 200 ml. of a 4% sodium hydroxide solution into a 500 ml. beaker. (To prepare hydroxide solution, add enough water to 20 gms. of NaOH pellets to make 500 ml. of solution.) Add a few drops of phenolphthalein indicator solution. Ask pupils why the whole solution turned red. Dip some red litmus paper in the solution and ask pupils why it changed color to blue. Slowly add a 4% solution of HCl to the sodium hydroxide solution, while stirring constantly.

(Prepare the acid solution by mixing 42 ml. of conc. hydrocloric acid with 460 ml. of water.) When you have added about 200 ml. of acid solution to the 500 ml. beaker, the red color will begin to become lighter. Add the acid solution a very little at a time until the color just disappears. Ask pupils why the red color turned to pink and then almost disappeared. Elicit the concept that the base, sodium hydroxide is no longer acting like a base. That is, it was neutralized. Dip another piece of red litmus paper into the solution and have pupils note that it did not turn blue.

4. Explain to pupils that in today's experiment they will see ways to neutralize some common household substances which are basic.

5. Distribute the trays containing the pupil materials listed above to groups of pupils. Guide them as to how the experiment will be conducted. Help them read the instructions on the worksheet.

SUMMARY:

1. When an acid is added to a base, it stops acting like a base.
2. When a base loses its properties, we say that it has been neutralized.
3. We can neutralize a base by mixing it with an acid.

HOMEWORK:

Ask pupils to do an experiment at home in which they neutralize a base by adding an acid to it. Pupils can neutralize soap by using vinegar. Plan the experiment with the pupils. Distribute the red and blue litmus paper so that they can test the solution.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 23. How can we make a base neutral?

MATERIALS:

250 ml. beaker with 75 ml. of water in it
eye dropper with some liquid soap in it
rubber stopper to fit the erlenmeyer flask
stirring rod
phenolphthalein indicator solution
red litmus paper
125 ml. erlenmeyer flask with 100 ml. of a 4% HCl solution previously prepared by the teacher

PROCEDURE:

In today's experiment you will see how soap, which is a base, can be made neutral.

1. Add a drop of liquid soap to your beaker which has water in it. Close the top of the beaker with a stopper and shake it so that the soap mixes with the water in the beaker. Take the stopper out of the beaker and add a few drops of phenolphthalein indicator solution. The color of the solution is now ____________________, because soap is an (acid, base) ______________________________.
2. Dip a piece of red litmus paper into the soapy water. The color of the litmus paper turned to ______________________.
3. Take the erlenmeyer flask with acid solution and slowly add it to the soap solution. Use the stirring rod to mix the soap solution as you slowly add the acid. Stop adding the acid solution when the soap solution turns pink.
4. Dip a piece of red litmus paper into the soap solution. Did the color of the litmus paper turn blue? (yes, no) _______________

Answer the following questions:

1. We know that soap is basic because it turned red litmus paper ________.
2. When we added an __________________ solution, the soap solution was changed so that it stopped acting like a base.
3. You can neutralize a base by mixing it with a ___________________.

E. HOW DOES WATER CHANGE WHEN IT BECOMES PART OF A SOLUTION?

LESSON 23. How can we make electricity go through water?

OUTCOMES:

1. Pure water does not conduct electricity.
2. When we dissolve some things in water the solution conducts electricity.

MATERIALS:

conductivity apparatus
seven 250 ml. beakers each filled half full with:
dry salt
salt water
sugar solution
dilute sulfuric acid
dilute hydrochloric acid
dilute sodium hydroxide

PROCEDURE:

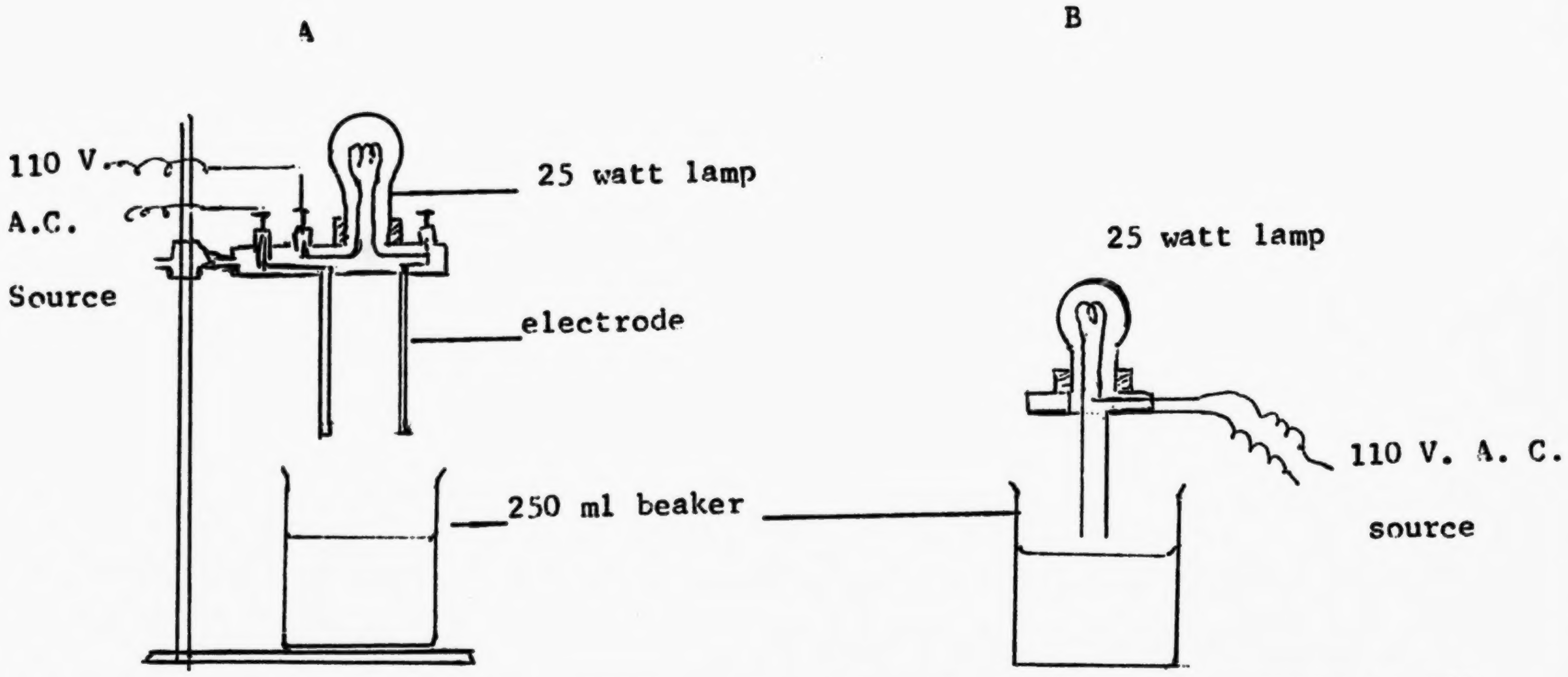
1. Motivate the lesson by a discussion of the importance of the wet cell battery in an automobile. Explain that inside the battery the metal parts and the liquid work together to produce electricity to help start the car.

2. Ask pupils whether they have ever seen electricity go through a liquid. Recall that people have gotten an electric shock when they touched an electrical device of some sort when their hands were wet or they were standing in water.

3. Explain that in today's lesson we will find out ways to make electricity go through water.

4. Introduce a diagram previously prepared of an conductivity apparatus (Conductivity of Solution Tester Cenco #81180). The diagrams can be drawn on a large piece of oak tag so that time will not be lost in preparing it.

   Note: Pupils should not be permitted to handle the electrical parts of the apparatus. They may help by rinsing beakers, stirring solutions, and recording data on the blackboard. As you perform the various parts of the demonstration have pupils record their results on their worksheets.



CAUTION: Do not rinse the electrodes or adjust them unless the current is off.

5. Set up apparatus as shown in diagram "A" above. Keep the electrodes in the air above the solution. Connect the apparatus to the source electricity and close the switch. Elicit from the class the observation that the light did not go on. Explain that the electricity cannot travel through because there is an "open" between the electrodes. Ask the question, "How can we make the light come on?" Turn off the current and connect a wire with an alligator clip at each end to each of the electrodes. Turn the current on. Pupils should observe that the light goes on. Make sure that the current is off, and remove the wire. Turn the current back on and place a wooden stick across the electrodes. Pupils will observe that the light does not go on. Explain that wood is a non-conductor of electricity.

6. Explain that if we dip the electrodes into a conductor the light will come on. If the material is not a conductor the light will not come on.

7. Test the materials listed below. Test by dipping the electrodes into each beaker with a sample of each one of the materials. As you test the various solutions the pupils should record the information on their worksheets. As you perform the various parts of the demonstration guide pupils through the worksheet.

8. Test materials in 250 ml. beakers

   a. water (distilled water if possible)
   b. dry table salt
   c. a solution of salt in water
   d. a sugar solution (Water does not make all substances into electrolytes.)
   e. dilute sulfuric acid
   f. dilute hydrochloric acid
   g. dilute sodium hydroxide (4g. of sodium hydroxide per 100 ml. of water)

   Have each beaker and solution ready before the demonstration so that time will not be wasted constantly rinsing beakers. As you proceed with the demonstration have pupils record the data on the worksheet.

SUMMARY:

1. Pure water does not conduct electricity.
2. Solutions of some acids, bases and salts conduct electricity.
3. Some solutions do not conduct electricity.

HOMEWORK:

Answer these questions:

1. Why do lifeguards chase us out of the ocean during a lightning storm?

2. Why shouldn't you touch a light cord while you are in the bathtub?

3. Name three things around the house that will make water conduct electricity.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 23. How can we make electricity go through water?

1. Copy diagram in space provided on the worksheet.

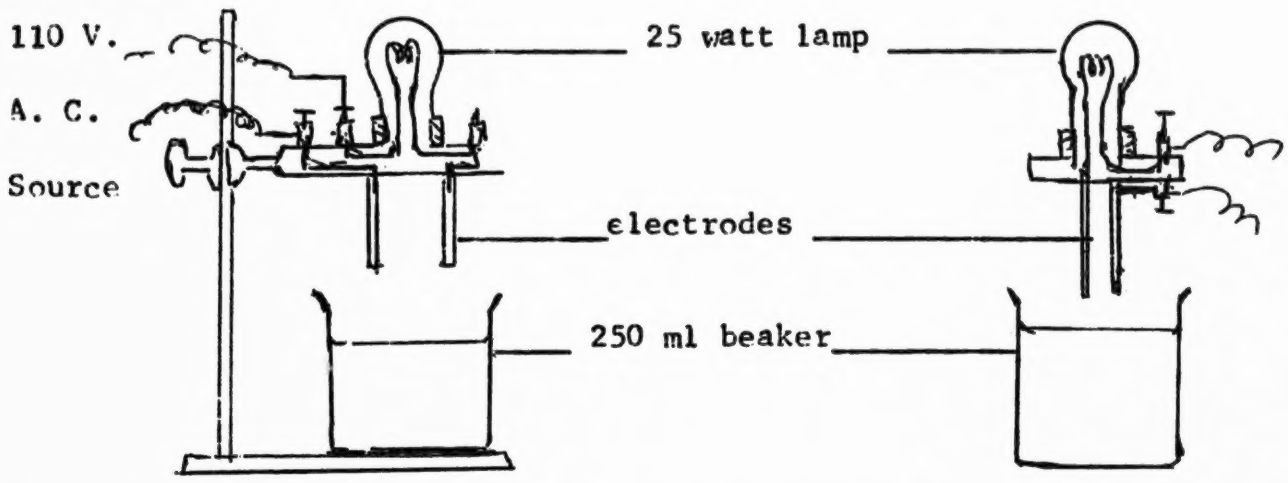


Diagram A

Diagram B

Caution: Do not rinse the electrodes or adjust them unless the current is off.

2. As your teacher tests a substance write the name of the substance in the first column. Then make a check in the good conductor column if the light comes on. If the light does not come on, put a check under non conductor. If the light is dim put a check under poor conductor.

SUBSTANCE	GOOD CONDUCTOR	NON CONDUCTOR	POOR CONDUCTOR

Answer these questions:

1. The solutions which will conduct the electricity are :

2. The things which did not conduct the electricity are:

3. For the light to go on the electric circuit must be (complete, incomplete) ___________________________.

E. HOW DOES WATER CHANGE WHEN IT BECOMES PART OF A SOLUTION?

LESSON 24. How cold is water when it turns to ice?

OUTCOMES:

1. To freeze water you must cool it.
2. Water freezes at 32 degrees Fahrenheit scale or 0 degree Centigrade scale.
3. Water and ice are just as cold at 0 degree C. or 32 degrees F. The temperature scales are just different.

MATERIALS:

Note to Teacher: Large amounts of ice are needed for this lesson. If the number of ice cubes is limited, ice cubes may be prepared in advance and stored in plastic bags in the freezer compartment of a refrigerator.

250 ml. beaker with 65 ml. of water
rock salt or plain salt
thermometer
ice cubes
tablespoon
paper towels

PROCEDURE:

1. Motivate the lesson by asking pupils how they can make ice cubes. Develop the fact that when they put the water filled trays into the freezing compartment of their refrigerator so that the water in the trays can be cooled.

2. When it is agreed that water must be cooled to change it into ice, this is followed by the question of how cold water must be to turn into ice.

3. Explain that in today's lesson they will find out at what temperature water freezes or turns into ice.

4. Distribute the trays containing the pupil materials listed above to groups of pupils. Take some time to train pupils to read either the Fahrenheit or Centigrade scale on a thermometer at two minute intervals. Have pupils practice locating the mercury column and reading the scale. After the pupils have had sufficient practice reading the thermometer, distribute the worksheets.

SUMMARY:

1. Water must be cooled to be changed to ice.

2. Water will turn to ice when its temperature has gone down to 32 degrees Fahrenheit or 0 degree Centigrade.

HOMEWORK:

Do this experiment at home to find out if water always freezes at the same temperature.

Fill two 6 ounce tumblers 1/3 full of water. Dissolve 2 or 3 tablespoons of salt in the water in one tumbler. Put both tumblers of water in the freezing compartment of a refrigerator. Look at the tumblers every five minutes. Did the water in both tumblers take the same amount of time to freeze? Why?

Note to Teacher: Water with something dissolved in it has a lower freezing point than pure water.

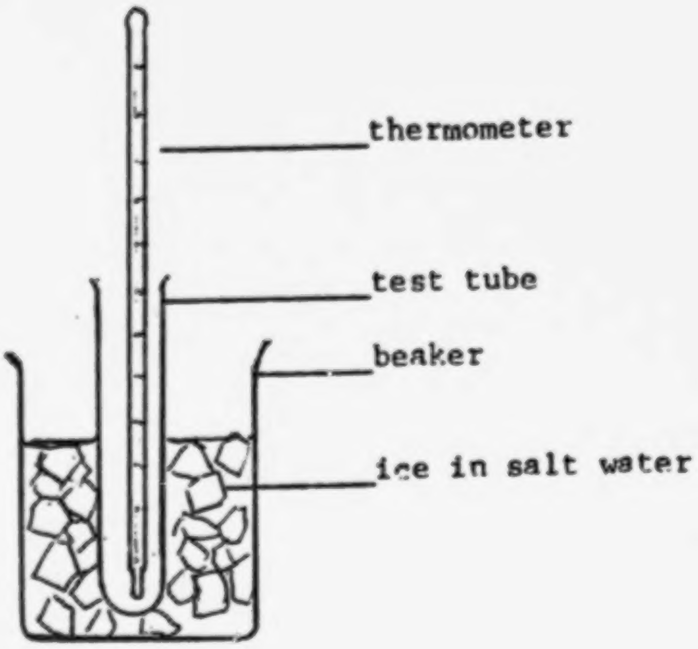
PUPIL WORKSHEET
(MAY BE DUPLICATED FOR EACH PUPIL)

LESSON 24. How cold is water when it turns to ice?

MATERIALS:

Note to Teacher: Large amounts of ice are needed for this lesson. If the number of ice cube trays is limited, ice cubes may be prepared in advance and stored in plastic bags in the freezer compartment of a refrigerator.

8" test tube with 10 ml. of distilled or demineralized water
250 ml. beaker with 65 ml. of water
rock salt or plain salt
thermometer
ice cubes
tablespoon
paper towels



PROCEDURE:

1. Take the 250 ml. beaker with water and add a heaping tablespoon of rock salt. Mix the salt and water with the spoon. Now add six ice cubes to the salt water.
2. Stir the salt water and the ice cubes for two minutes. Use the thermometer to take the temperature. Stir until the temperature of the ice and water is 0 degree Centigrade.
3. Stand the test tube of water in the beaker. Carefully wipe the thermometer with a paper towel. Put the thermometer in the test tube as shown in the diagram.

Time	Temperature
0 minutes	
2 minutes	

4. Write the temperature of the water in the test tube as soon as you put it into the beaker. This is 0 time. Two minutes later write the temperature again. Write the temperature every two minutes. Stir the ice cube mixture with the spoon. Watch the water in the test tube. Put a star (*) next to the time and temperature where freezing just starts. Keep taking the temperature until about half the water is frozen.

Answer the following questions:

1. To make ice, you must cool water by putting it in something with a (lower, higher) ______________ temperature.

2. It took _____________ minutes for the water to begin to freeze.

3. Water will freeze at a temperature of _____________ degrees Centigrade or ______________ degrees Fahrenheit.

E. HOW DOES WATER CHANGE WHEN IT BECOMES PART OF A SOLUTION?

LESSON 25. How Can We Keep Water From Freezing?

OUTCOMES:

1. Pure water has a freezing point of 0 degrees C or 32 degrees F.
2. When water is mixed with a liquid which freezes at a lower temperature the resulting mixture has a freezing temperature which is lower than that of pure water.

MATERIALS:

250 ml. beaker with 50 ml. of cold water
6 or 7 ice cubes
2 or 3 tablespoons of rock salt
8" test tube with 15 ml. of cold water and 5 ml. of a permanent anti-freeze
plastic spoon
centigrade-fahrenheit thermometer
8" test tube with 10 ml. of cold water and 10 ml. of a permanent anti-freeze

PROCEDURE:

1. Recall with pupils some of the things they learned in the previous experiment.
   Ice and water are two forms of the same substance.
   Water changes to ice when it is cooled to the freezing point (32 degrees F, 0 degrees C) or below.

2. Discuss with pupils the way in which anti-freeze is used to protect an automobile during the winter. From this discussion develop the fact that during the winter temperatures go below 32 degrees, the freezing point of water. If the water in the radiator of a car froze, it would cause serious damage to the engine. Elicit from pupils that a liquid anti-freeze is added to the water in the radiator to keep it from freezing.

3. Explain that in today's lesson pupils will see how something can be mixed with water so that it will freeze at a temperature below 32 degrees F or 0 degrees C.
   Note To Teacher: CAUTION - Ethylene Glycol or anti-freeze is a poisonous liquid. Do not permit pupils to handle this liquid. If some spills on your hands, wash them with soap and water.

4. Distribute the pupil worksheets and explain to them how they will use the tables to record the data. As you perform the various parts of the demonstration guide pupils to record the data.

5. Pour about 50 ml. of cold water into a 250 ml. beaker and add 6 or 7 ice cubes. Also add 2 or 3 tablespoons of rock salt and stir with a plastic spoon for at least one minute.

6. Take an 8" test tube and fill it with 15 ml. of cold water and 5 ml. of anti-freeze. Use a thermometer to read the temperature of the solution in the test tube. Have a pupil assist you. Stir the solution in the 8" test tube and use the plastic spoon to stir the ice-water mixture. Read the thermometer every two minutes and have pupils record the temperature on their worksheets. Have some pupils assist you. When the solution in the 8" test tube begins to freeze, ask pupils to put a star next to the time and temperature when freezing just started. Ask pupils to calculate how many degrees below the normal freezing temperature (32 degrees F) of pure water the solution of anti-freeze and water was when it began to freeze.

7. Perform the same demonstration with another 8" test tube with a mixture of 10 ml. of water and 10 ml. of anti-freeze. Have pupils record the temperature at two minute time intervals on their worksheets as in the previous demonstration. They should note that this mixture has a still lower freezing point than the previous mixture.

SUMMARY:

The freezing temperature of water can be lowered by dissolving some substances (anti-freeze) in it.

HOMEWORK:

Do an experiment at home to find out if you can use other substances to keep water from freezing.

Put some cold water, ice cubes and salt into an empty jar or can. Fill a four ounce glass half full of water and dissolve two teaspoons of salt in it. Put the glass with the salt-water in the ice water and use a thermometer to see at what temperature the salt water freezes.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 25. How Can We Keep Water From Freezing?

PROCEDURE:

As your teacher gives you the temperature and time write them down in the right column on the chart below. Put a star (*) next to the temperature and time when the liquid begins to freeze.

SOLUTION

15 ml. of water with 5 ml. of anti-freeze		10 ml. of water with 10 ml. of anti-freeze	
Time	Temperature	Time	Temperature

Answer the following questions:

1. A solution of anti-freeze and water has a (higher,lower)_________ freezing point than pure water.

2. When more anti-freeze is mixed with water the(higher, lower)_______ the freezing point of the mixture.

3. Tell in your own words why salt was added to the ice cubes.

____

____

____

____

E. HOW DOES WATER CHANGE WHEN IT BECOMES PART OF A SOLUTION?

LESSON 26. How hot does water get when it boils?

OUTCOMES:

1. To boil water you must heat it.
2. Water boils at 212° fahrenheit scale or 100° centigrade scale.
3. Water is just as hot at 100° centigrade as it is at 212° fahrenheit. The scales are just different.

MATERIALS:

Pupil

8" test tube containing 10ml. of water
thermometer
2 test tube clamps
ringstand
split, one-hole rubber stopper (made by cutting a slit in the stopper)
alcohol burner
matches

PROCEDURE:

1. Recall with the class from a previous lesson that pure water froze at a definite temperature. Ask pupils what temperature this is on fahrenheit and centigrade scale. Elicit that water had to be cooled to make it freeze. Ask pupils what would have to be done to water in order to make it boil. Explain that in today's lesson, pupils will do an experiment to find out at what temperature water boils.

2. Before distributing the trays for the experiment, carry out the following activities in order to make sure that the class is adequately prepared to perform the experiment.

3. Demonstrate how to recognize when water is boiling. Boil some water in a beaker. Make it very clear to pupils that bubbling starts at the bottom of the container.

4. Explain to the class that when they heat the water they should observe and record the temperature of the water as it is heated.

5. If there is no large clock in the classroom, start all the pupils at the same time and announce the time at two minute intervals.

6. Distribute the trays containing the pupil materials listed above to groups of pupils. Take some time to review with pupils how to read either the fahrenheit or centigrade scale on a thermometer at two minute time intervals. Give pupils time to practice locating the mercury column and reading the scale.

SUMMARY:

1. When you heat water its temperature goes up.
2. Water will boil when its temperature has gone up to 212° fahrenheit or 100° centigrade.

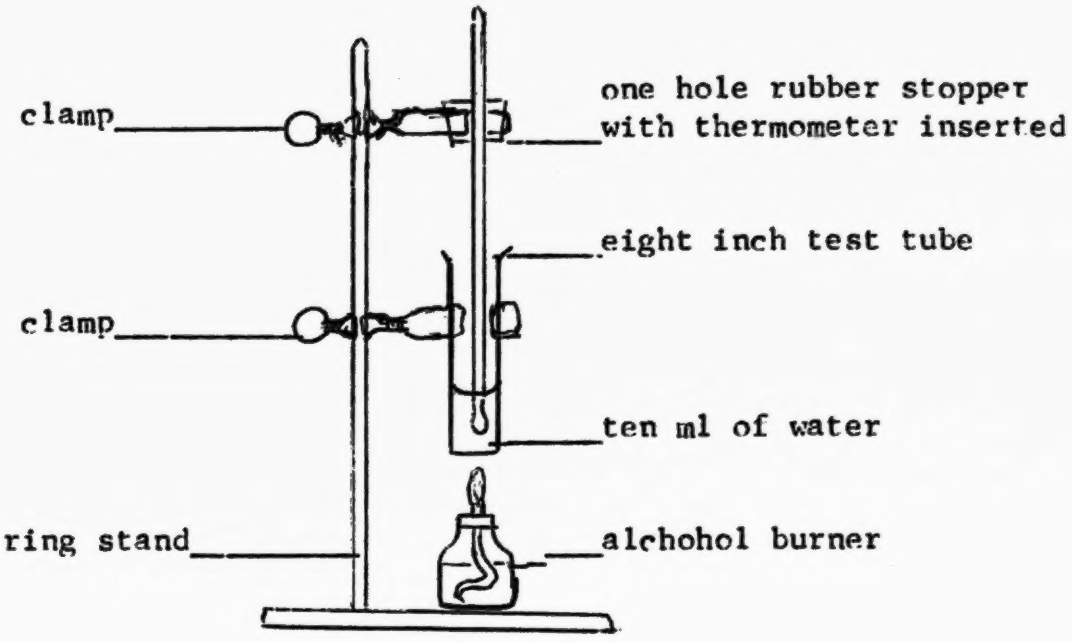
HOMEWORK:

1. When water boils, it turns into ____________________.

2. The bubbles in boiling water have __________________ in them.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 26. How hot does water get when it boils?


clamp
one hole rubber stopper with thermometer inserted
eight inch test tube
clamp
ten ml of water
ring stand
alchohol burner

MATERIALS:

8" test tube containing 10 ml. of water
thermometer
2 test tube clamps
ringstand
a split one hole rubber stopper (made by cutting a slit in the stopper)
alcohol burner
matches

PROCEDURE:

1. Set up the equipment as shown in the diagram above. Set the thermometer so that the bottom is in the water but not touching the bottom or sides of the test tube. The thermometer should be set in the split rubber stopper. The stopper should be held by a clamp. The stopper should not hide the numbers from 90°C to 110°C.

2. Before you begin the experiment ask your teacher to check your set-up. Record the temperature of the water in the 8" test tube next to 0 time on the table below.

3. Light your burner when the teacher tells you to do so.

Time Minutes	Temperature
0	

Every 2 minutes your teacher will give you a signal. Write the time and the temperature at the table on the left. Do not put your face over the open test tube because the hot water may spatter in your face. Put an * next to the temperature at which the water started to boil. Heat for a few minutes after the water begins to boil to see if the temperature keeps going up. Then stop heating and put out the flame.

Anwer the following questions:

1. The water boiled at a temperature of __________ °C or _________ °F.
2. Heating while the water was boiling (did, did not) ______________ raise the temperature of the water.

E. HOW DOES WATER CHANGE WHEN IT BECOMES PART OF A SOLUTION?

LESSON 27. How can we change the boiling point of water?

OUTCOMES:

1. Dissolved solids raise the boiling temperature of water.
2. The more solid dissolved, the higher will be the boiling temperature of water.

MATERIALS:

Pupil

8" test tube containing a saturated solution of potassium chromate
Note: prepare a saturated solution of potassium chromate by dissolving 208 gms. of potassium chromate crystals ($K_2 Cr O_4$) in 333 ml. of water.
thermometer
2 test tube clamps
ringstand
a split, one-hole rubber stopper (made by cutting a slit in the stopper)
alcohol burner
matches

PROCEDURE:

1. Review with the class, through a discussion, the following information learned in previous lessons:
   a) When water is heated, the temperature goes up.
   b) The temperature at which water boils is 100° centigrade scale or 212° fahrenheit scale.
   c) Water which has something dissolved in it has a freezing point which is different from that of pure water.

2. Pose a question to the class as to how dissolved solids in water would affect its boiling point. Question further as to whether the boiling temperature would be raised or lowered.

3. From these questions develop the aim of the lesson and explain that in today's lesson, pupils will find the boiling point of water which has something dissolved in it.

   Note to the teacher: A saturated solution of potassium chromate ($K_2 Cr O_4$) will boil at about 106° C or 223° F.

SUMMARY:

Water which has something dissolved in it has a higher boiling point than pure water.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 27. How can we change the boiling point of water?

MATERIALS:

For Pupils:

8" test tube containing a saturated solution of potassium chromate
Note: prepare a saturated solution of potassium chromate by dissolving 208 gms. of potassium chromate crystals ($K_2 Cr O_4$) in 333 ml. of water
thermometer
2 test tube clamps
ringstand
a split, one-hole rubber stopper (made by cutting a slit in the stopper)
alcohol burner
matches

PROCEDURE:

1. Set up the apparatus for this experiment the same way you did in the last lesson. Set the thermometer so that the bottom is in the water but not touching the bottom or sides of the test tube. The thermometer should be set in the split rubber stopper. The stopper should be held by a clamp. It should not hide the numbers from 90° to 110° C.

2. Before you begin the experiment ask your teacher to check your apparatus. Write down the temperature of the water in the 8" test tube next to 0 time on the table below.

3. Light your burner when the teacher tells you to do so.

Time Minutes	Temperature

Every 2 minutes your teacher will give you a signal. Write the time and the temperature at the table on the left. Do not put your face over the open test tube because the hot water may spatter in your face. Put an * next to the temperature at which the water started to boil. Heat for a few minutes after the water begins to boil to see if the temperature keeps going up. Then stop heating and put out the flame.

Answer the following questions:

1. The water boiled at a temperature of __________ °C or __________ °F.

2. Which is hotter, boiling pure water or a boiling solution?

A. MEASUREMENTS

LESSON 1. What is the long and short of it?

OUTCOMES:

1. Length can be measured in different units.
2. The basic units used in the U.S.A. are feet and inches and are called English Units.
3. Skill will be developed in construction and use of a ruler.

MATERIALS:

1. Soda straws cut to a length of 6 inches.
2. Paper strips cut the same length as the soda straws.
3. Pencils to mark the soda straws.
4. Rulers calibrated in inches and centimeters.

PROCEDURE:

1. Distribute the pupil worksheet to the students.

2. Distribute the 6 inch soda straws to the class, make sure there is one for each student. Do not tell the length of the straws.

3. Ask the students to measure common objects such as their books, desks, etc. using the soda straws as rulers. (results such as 2 straw lengths or 3½ straw lengths will be obtained). Write answers on worksheet.

4. Explain to the class that this is the way that measurements were begun but that since there were no soda straws then the length of the human foot was chosen as a standard.

5. Ask the students to measure the length of their feet in soda straws. (the results should vary from 1½ to 2 straw units)

6. Develop in a short discussion the fact that the human foot varies too much in length to be used as a standard of length. Cite examples such as purchasing carpets from the person with the largest foot and from the person with the smallest foot.

7. Suggest to the class that they use 2 soda straw lengths as a standard of measurement. Tell them that this standard is known as the foot. Explain the foot as part of the English system of measurement.

8. Ask the class how long their soda straws are now. Make the point that the length of the soda straw has not changed but that we now call it ½ foot.

9. Ask the class to measure the length of their middle fingers using the soda straws. Develop the need for smaller divisions on the straws.

10. Distribute the paper strips that you have prepared. Challenge the students to mark their rulers with six divisions using only a pencil and the paper strips. HINT: Its easy to divide the paper into six parts is you fold it in half first. See pupil worksheet.

11. Distribute 12 inch rulers. Have the students compare their rulers with the manufactured ones.

12. Discuss with the students the need for a standard ruler to refer to.

SUMMARY:

The following ideas should be developed from the class through the activities.

1. The length of an object is the same no matter which system of units is used to measure it.

2. The system of units used to measure length in the U.S.A. is called the English System.

3. A universal standard is necessary so that people may understand what is meant by a length such as a foot.

HOMEWORK:

1. Complete and hand in the pupil work sheet.

2. (Extra assignment) Find a way to mark your ruler with $\frac{1}{4}$ inch divisions.

TEACHER REFERENCE:

See end of this unit for supplemental references on length. These may be duplicated for pupil use.

* NOTE TO TEACHERS:

The tools that the student constructs in the early lessons will be used in later experiments. It is suggested that each student bring in a cigar box for his constructed equipment and that this be kept in the classroom for future use.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPIL USE)

LESSON 1. How can you measure without a ruler?

MATERIALS:

Soda straw
Paper strip
Pencil
12 inch ruler - for use as a reference.

1. Measure the length of common objects in soda straws.

	OBJECT	LENGTH
(SAMPLE)	a book	2 soda straws
	________	________
	________	________
	________	________
	________	________

2. Measure the length of your foot in soda straws.

   The length of my foot is ________ soda straws.

3. Measure the length of your middle finger using your soda straws.

   The length of my middle finger is ________ soda straws.

4. Mark off your ruler into six equal parts using the paper strip and a pencil. There is a trick in folding a paper into six equal parts - see if you can find out what it is.

5. Which is a better ruler, the soda straw that you made or the ruler that the teacher gave out for you to look at?____________Why?

   Are the inches on your ruler larger or smaller than the inches on the manufactured ruler? ____________

6. List two ways that you could use to make a better straw ruler.

   a.

   b.

7. Using the experience that you have gained make a new and better soda straw ruler. See if you can mark off your new ruler with inch and $\frac{1}{4}$ inch divisions.

MEASUREMENTS AND ENERGY IN PHYSICS

A. MEASUREMENTS

LESSON 2. What is the long and short of it in Europe?

OUTCOMES:

1. In Europe and in almost all scientific work the system of units used is not the English System but the Metric System.
2. The basic units of length in the Metric System are the meter and the centimeter.
3. There are about 2.5 centimeters in one inch.
4. Many skills may be developed in the construction of scientific equipment.

MATERIALS:

soda straws cut to a length of 12 centimeters
paper strips cut to the same length as the soda straws (12 cm.)
pencils
six inch ruler constructed in previous lesson
meter stick

PROCEDURE:

1. Distribute the following items to each student:
   a. pupil worksheet
   b. soda straw cut to a length of 12 centimeters
   c. cigar box containing ruler constructed in previous lesson
   d. paper strips cut to a length of 12 centimeters

2. Have the students recall from the previous lesson that they could use this unmarked soda straw to measure length.

3. Have the students measure the length of their feet using the unmarked soda straws that you have just given out. Ask the question, "Why is it that the results of todays measurements are different from yesterdays?" The response that the soda straws are of different lengths should be elicited (see pupil worksheet).

4. Explain to the class that in Europe the basic unit of length is different than in this country and that it is the European system that is used im most scientific work. The scientific system of measurements is called the Metric System.

5. Have the students mark their soda straws into 12 equal divisions. This can be done by dividing the straw in half twice and then dividing each section into thirds. Tell the students that each division on their new rulers is called one centimeter. 100 centimeters are called one meter. One tenth of a centimeter is called one milimeter. You may add that the prefix centi means one one-hundredth 1/100 and that the prefix mili means one one-thousandth 1/1000 (metric measurements are based on the meter as the basic standard).

6. Have the students measure the length of their feet in centimeters. Record the result in the proper space on their worksheet.

7. Challenge the students to find out how many centimeters there are in one inch. (they can do this by using the ruler they constructed in the last lesson). (answer 2.54cm. = 1 inch)

8. Distribute meter sticks to the students and have them complete the pupil worksheets.

SUMMARY:

1. The unit of length in the metric system is one centimeter.
2. 2.54 centimeters equal 1 inch.
3. Length may be measured in either centimeters or inches. Scientists, however, prefer the Metric System.

HOMEWORK:

1. Complete pupil worksheet.

2. Construct a ruler that shows both inches and centimeters.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 2. How tall would you be in Europe?

MATERIALS:

unmarked soda straw
strip of paper
pencil
paper strip the same length as the soda straw
science kit (the cigar box containing the ruler from yesterday's experiment)
meter sticks

PROCEDURE:

1. Measure the length of your foot in soda straws. The length of my foot is ____________ soda straws. Why are the results of today's measurements different from those of yesterday's results?______________
____

2. Mark your soda straws into 12 equal lengths. Use the paper strip to get equal parts. The trick in dividing the straw into 12 parts is almost the same as the one for getting six parts. Your teacher will show you how.

3. Each division on your soda straw is now one centimeter long. Measure the length of the following objects in centimeters.

OBJECT	LENGTH
my foot	________
one foot (12 inches)	________
a pencil	________

4. Using the ruler that you made yesterday and the ruler that you made today find out how many centimeters there are in one inch.

________________ centimeters = 1 inch

5. Using the ruler that the teacher has given out, find out how many centimeters there are in one inch.

________________centimeters = 1 inch

6. Which of the above answers are better? ______________________
Why? ______________________________
____

7. Using the rulers that you have made and the rulers that your teacher has given out, answer the following questions:

_____________centimeters = one meter
_____________milimeters = one centimeter
_____________milimeters = one meter

HOMEWORK:

1. How tall are you inches? My height in inches = ____________
2. How tall are you in centimeters? My height in centimeters = ____________
3. How tall are you in meters? My height in meters = ____________
4. How tall are you in milimeters? My height in milimeters = ____________

HINT: Once you have found your height in inches you can answer the rest of the questions without using any ruler, remember how many centimeters there are in one inch.

A. MEASUREMENTS

LESSON 3. How large is your hand?

OUTCOMES:

1. Area is measured in square units.
2. A unit of area in the English System is the square inch.
3. A unit of area in the Metric System is the square centimeter.
4. Irregular areas may be estimated by counting the number of squares of known areas that they contain.

MATERIALS:

science kits composed of previously constructed materials

graph paper: (may be duplicated with pupil worksheet)

a) 1 inch X 1 inch
b) 1 centimeter X 1 centimeter

cardboard rectangles:

a) 1 inch X 1 inch
b) 2 inches X 3 inches
c) 4 centimeters X 8 centimeters

pencils

PROCEDURE:

1. Distribute the following materials to each pupil:

   pupil worksheet
   cardboard square 1 inch X 1 inch
   graph paper 1 inch X 1 inch grid
   science kits

2. Challenge the pupils to tell you how large their cardboard squares are.

3. Show the class that when the square is placed on the 1 inch X 1 inch graph paper it will cover exactly one square.

4. Have pupils measure the sides of the square with their inch ruler. When they have seen that each side of the square is one inch , define this for them as the unit of area known as one square inch.

5. Review in a short discussion the method of finding the area of rectangles. Distribute the 2x3 inch rectangles and have the pupils measure the area using their rulers first and then by counting the number of squares the rectangle covers. Establish that both methods are really the same but that one is shorter.

6. Ask the pupils to estimate the area of their hands in square inches. A good question to ask is, "Who has the largest hands?" Have them record their estimates on their worksheets.

7. Ask the class how they could improve their estimates using the graph paper. Develop from this that by drawing the outline of their hands on the graph paper and counting the number of squares that were covered, their estimates would be improved. Have the pupils do this and record their results on their worksheets.

8. Distribute the 4X8 centimeter cardboards and the 1X1 centimeter graph paper and have the pupils complete their worksheets.

SUMMARY:

1. Area is measured in square inches and square centimeters.
2. The area of rectangles may be found by multiplying the length by the width. (L X W)
3. An irregular area may be estimated by counting the number of squares that it covers.

HOMEWORK:

1. Complete and hand in the pupil worksheet.

2. Do the special assignments on the worksheet.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 3. How large is your hand?

MATERIALS:

science kits
graph paper (large and small squares)
assorted cardboard rectangles
pencil

PROCEDURE:

1. How many squares on the graph paper does the cardboard square that your teacher has just given you cover?

   1 cardboard square covers __________ square on the graph paper.

2. How many square inches does your hand cover? (Give your best guess).

   I estimate that my hand covers ________ square inches.

3. By tracing the outline of your hand on the graph paper and counting the number of squares that it covers improve the estimate of the area of your hand.

   Note: (Since your hand will cover parts of squares in addition to whole squares you will have to estimate how many whole squares the parts add up to).

   My improved estimate of the area of my hand is ____________.

4. Your teacher will give you some new graph paper and a new rectangle. This set of materials uses the metric system of measurements. Use the centimeter ruler in your science kit to find out what the area of the squares on this piece of paper is. Since the unit of area in the english system is one square inch the unit of area in the metric system (the one that uses centimeters) is one square______________.

   The squares on the new piece of graph paper are ___________ in area.

5. Measure the area of the cardboard squares in square centimeters. Write the area in square inches on one side of the squares and write the area in square centimeters on the other.

6. Special problem: Using the graph paper that has square centimeters on it, estimate the area of your hand in square centimeters.

   The area of my hand is ___________square centimeters.

7. Extra Problem: How many square centimeters are there in one square inch?

   Hint: You can find the answer two different ways. The first way is using the formula for area (l x w), the second is by counting squares.

PUPIL WORKSHEET

A. MEASUREMENTS

LESSON 4. How much space does your cigar box take up ?

OUTCOMES:

1. Volume is a measurement of the space that an object occupies.
2. Rectangular volumes are measured by multiplying length by width by depth (V = LxWxD).
3. The unit of volume in the English System is one cubic inch.
4. The unit of volume in the Metric System is one cubic centimeter.
5. Measuring volume is really counting the number of standard cubes that will fill a space.

MATERIALS:

scissors
rulers calibrated in both inches and centimeters
science kits in cigar boxes

PROCEDURE:

1. Distribute pupil worksheets and science kits.

2. Have the pupils construct the paper cubes as per the instructions on the worksheets. After they have finished constructing the cubes have them measure the sides of each cube in inches. Define the volume of this cube as the standard volume, one cubic inch.

   Note: After this point the pupils should be encouraged to use standard rulers to improve the accuracy of their results. It would be worthwhile to have a short discussion of this with the class.

3. Challenge the class to find out how many of the cubes that they have constructed would be required to fill their cigar boxes. Have the class suggest various methods of solving this problem,such as,tracing the outline of the cube in the box, etc. Have the pupils make this estimate and record their answers on the pupil worksheet.

4. Distribute the rulers and ask the class if this will help them solve the problem more easily. (Do not expect that all the pupils will be able to solve the problem at this point.)

5. Have the pupils write their names on the paper cubes and collect them. Arrange the cubes on your desk in the shape of a cigar box. From this develop the idea that a quick way of counting the number of boxes is to multiply the length by the width by the depth (V = LxWxD). Return the paper cubes to the pupils.

6. Have the pupils measure the volume of their cigar boxes using their rulers. Reinforce, several times, that the volume is measured in CUBIC inches.

7. Have the pupils complete the pupil worksheets.

SUMMARY:

Guide the pupils to express, in their own words, the following ideas:

1. Volume is measured in cubes.
2. The unit of volume in the English System is the cubic inch.
3. Measuring the volume of an object is really counting how many standard cubes are needed to fill it up.

HOMEWORK:

Complete the homework assignment included with the pupil worksheet.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 4. How much space does your cigar box take up?

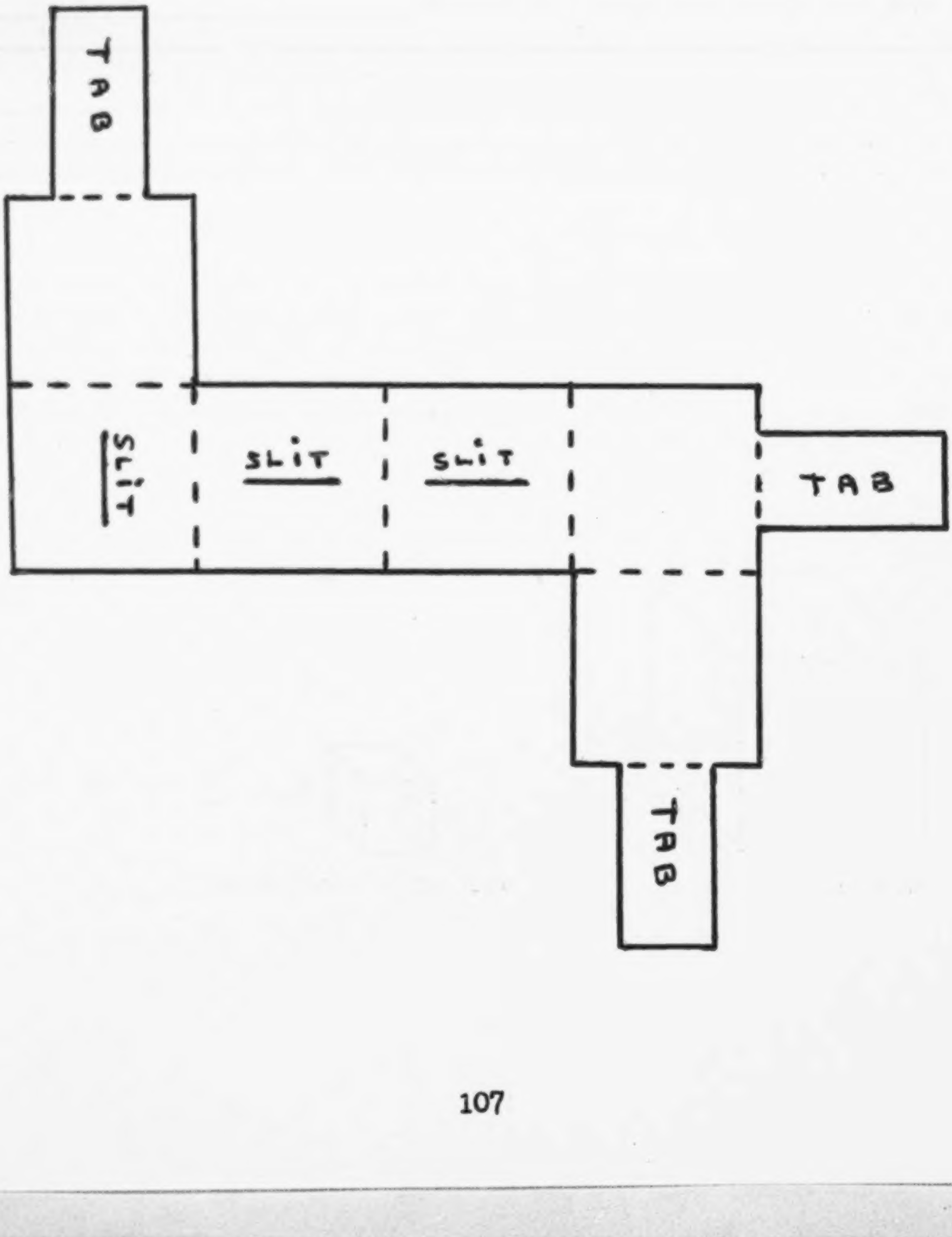
MATERIALS:

scissors
rulers calibrated in inches and centimeters
science kits in cigar boxes

PROCEDURE:

1. Cut out and put together the cube shown below:

   Cut on all the solid lines. (Don't forget the slits.) Fold on all the dotted lines. When you have folded up the cube, put the tabs in the slits.



2. Measure the sides of your cube in inches.

length = ____________________
width = ____________________
depth = ____________________

3. Estimate how many one cubic inch cubes your cigar box will hold.

My cigar box will hold ____________ cubic inches.

4. Find out how many cubic inches your cigar box will hold by multiplying the length by the width by the depth.

length = ____________________ inches
width = ____________________ inches
depth = ____________________ inches

length x width x depth = _______ x _______ x _______ = _______cubic inches

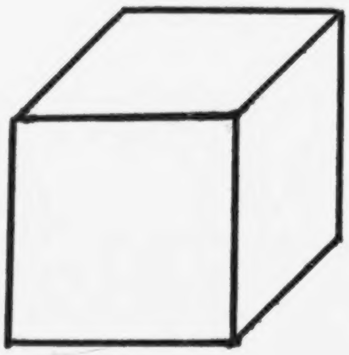
The volume of my cigar box is _______________ cubic inches.

5. Which method of finding the volume is better: the first one you used or the one where you used the ruler? ______________________________
____.

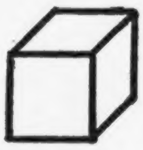
Why? ____
____
____.

HOMEWORK:

Finding the volume that an object takes up is done the same way in the Metric System as it is in the English System. The only difference is that in the Metric System we measure in centimeters instead of in inches so that our volumes come out in cubic centimeters instead of cubic inches. A cubic centimeter is a small cube that measures one centimeter on each edge.



one cubic inch



one cubic centimeter

See if you can find an object that measures exactly one cubic centimeter in volume. You might try a small sugar cube, or make one out of paper or clay or wood.

Questions:

1. Which is larger one cubic inch or one cubic centimeter?
   ____

2. How many cubic centimeters are there in one cubic inch?
   __________ cubic centimeters = one cubic inch

MEASUREMENTS AND ENERGY IN PHYSICS

A. MEASUREMENTS

LESSON 5. Why does a scale have a heart of steel?

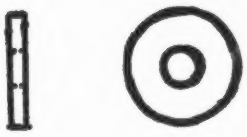
OUTCOMES:

1. A scale (spring type) is nothing more than a calibrated spring.
2. A spring can be made from nichrome wire by tempering it.

MATERIALS:

Teacher and Pupils

nichrome wire - 27 gauge, 30 centimeters long
set of 7 metal washers weight 1 gram each, these may be obtained in the school shop, the approximate size of the washer is as shown:



science kits
paper clip
steel nut
button
small cork
test tube or dowel with a diameter of approximately 1½ centimeters
(In addition you will also need the following materials.)

1. bunsen burner
2. prepared spring of tempered nichrome wire

   Note: Prepare the tempered spring in the following manner:

   Wrap a nichrome wire (30cm.) around a test tube or dowel to make a coil with eight turns. Allow a little surplus wire at both the beginning and the end of the spring. Heat the spring red hot in the flame of a bunsen burner. Let it cool slowly.

3. spring scale calibrated in grams

PROCEDURE:

1. Distribute pupil worksheets and materials listed above.

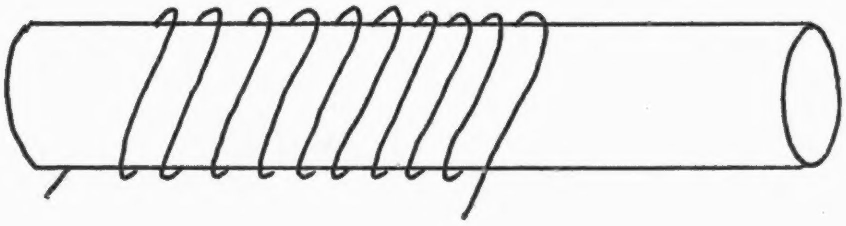
2. Have the pupils heft the metal washers and define the weight of each washer as the standard unit of weight - one gram. Have them record this weight on their worksheets.

3. Direct the pupils' attention to the small objects they have received (paper clip, button, steel nut, cork). Ask the pupils how many grams each object weighs. Have them make their estimates and record them on their worksheets.

4. Challenge the class in the following way: "An estimate is fine, but if we were buying something it might not be good enough. Let's make a scale and really find out how much these objects weigh".

5. Display a spring scale to the class and elicit from them that to build a scale we must first construct a spring. Tell the group that since they do not have any springs they will have to build them.

6. Direct the pupils' attention to the nichrome wire and the dowel. Demonstrate for the class the method of winding a spring on the dowel (or test tube).



Note: It is important to have eight turns on the spring.

7. After they have made their springs, take the spring that you have tempered and show them how springy it is. Tell them to see how springy their springs are. Since the springs will not have been tempered, they will have very little spring. Explain that this is a problem that metalurgists solve by tempering. Define the word metalurgist. Explain and demonstrate tempering by heating all their springs (several springs may be tempered at once by holding them with a test tube holder).
CAUTION: Allow the springs to cool fully before picking them up

8. By comparing a tempered spring and an untempered spring, define the word "elastic" as the ability of a spring to return to its original shape after being stretched. By stretching the spring too much, define the elastic limit as the amount of stretch that will cause an object to be bent or stretched out of shape (not return to its original shape). Elicit from the class examples of cases when objects have been stretched beyond their elastic limits.

9. Make sure the pupils keep their springs in their science kits. they will need the springs tomorrow.

SUMMARY:

1. Science depends on knowledges from many areas (cite the example of physics and metalurgy).
2. Tempering with heat may make a metal more elastic.
3. When you stretch a spring too much it does not return to its original shape ... it has passed its elastic limit.

HOMEWORK:

Complete vocabulary section of the pupil worksheet.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 5. Why does a scale have a heart of steel?

MATERIALS:

nichrome wire 30 centimeters long
seven metal washers
paper clip
steel nut
button
small cork
test tube or dowel with a diameter of 1½ centimeters
science kit in cigar box

PROCEDURE:

1. The weight of one washer is __________ ____________.

2. Estimate the weights of the following items (use grams).

ITEM	ESTIMATED WEIGHT IN GRAMS
Paper clip	Grams
Button	Grams
Small cork	Grams
Steel nut	Grams

3. Construct a spring following your teacher's directions. Keep your spring in your science kit since you will need it for tomorrow's experiment.

4. Vocabulary

A metalurgist is ______________________________

____.

Tempering means ______________________________

____.

Elastic means ________________________________

____.

If you stretch a spring beyond its elastic limit it will not

____.

A. MEASUREMENTS

LESSON 6. How is a spring scale constructed?

OUTCOMES:

Scientific instruments may be constructed with simple and readily available materials.

MATERIALS:

Teacher and Pupils

4 plastic soda straws (about 20 centimeters long)
paper clip
modeling clay
straight pins
paper strip $1\frac{1}{2}$ cm. x 20 cm.
science kits (including 7 one gram washers and the tempered springs from lesson 5)
scissors
ruler calibrated in centimeters

PROCEDURE:

1. Distribute all materials and pupil worksheets.

2. Recall with the pupils the difficulty of estimating the weight of and the need for scales.

3. Draw a diagram of the scale the pupils are to construct on the blackboard (see pupil worksheet) or prepare a model before class and display the finished project. Discuss the function of each part very briefly.

4. Construct the scale step by step with the pupils following the instructions in the pupil worksheet.

5. Collect the finished scales and store them in a safe place, they will be needed for the next lesson.

SUMMARY:

Review the steps in the preparation of the tempered spring and the spring balance. If time permits, have the pupils come up to the front of the room to display and explain their model.

HOMEWORK:

See pupil worksheet.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

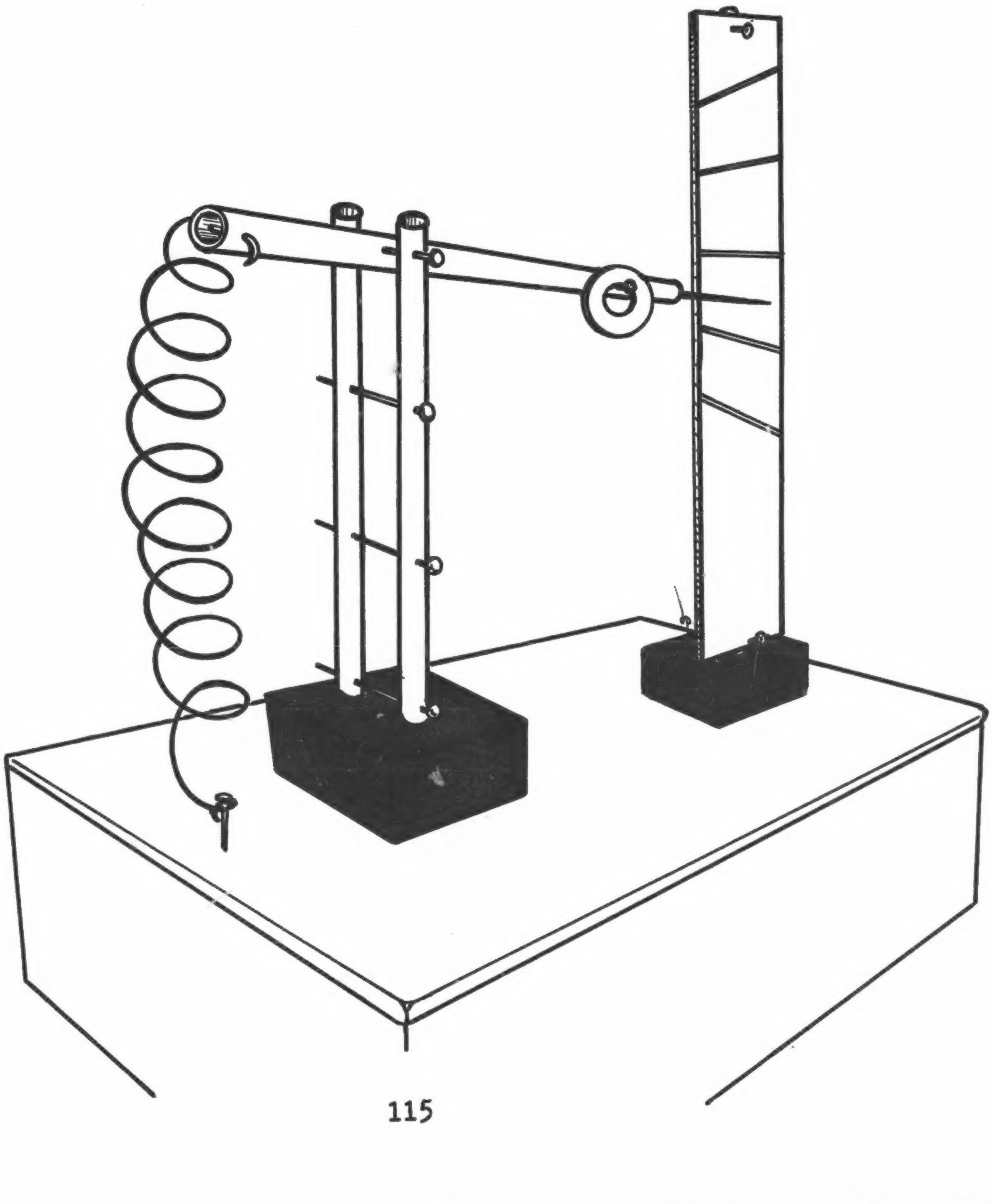
LESSON 6. The construction of a spring scale.

MATERIALS:

4 plastic soda straws (about 20 centimeters long)
paper clip
modeling clay
straight pins
paper strip $1\frac{1}{2}$ centimeters x 20 centimeters
science kits (including the tempered spring from lesson 5)
scissors
ruler calibrated in centimeters

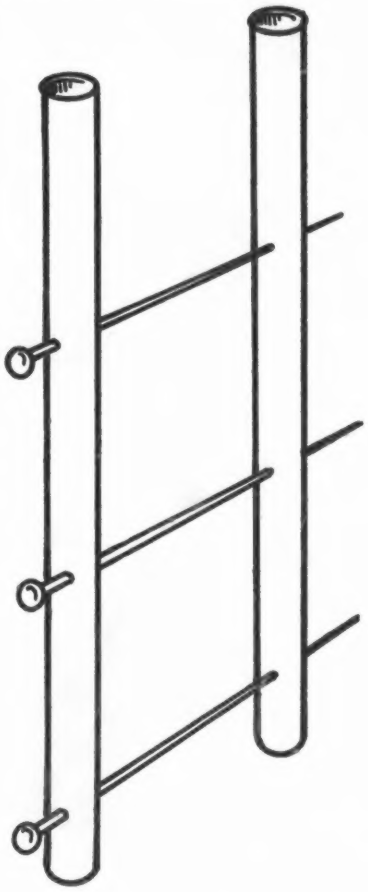
PROCEDURE:

1. As you follow the instructions listed below, discuss with your teacher the different parts of the scale that you are going to build. You should make a note on your diagram of anything that you think will help you in making the scale.



2. You are now ready to build your scale...... cut one of the soda straws into two equal lengths.

3. Using straight pins fasten these short straws together (see diagram of the "pointer holder").



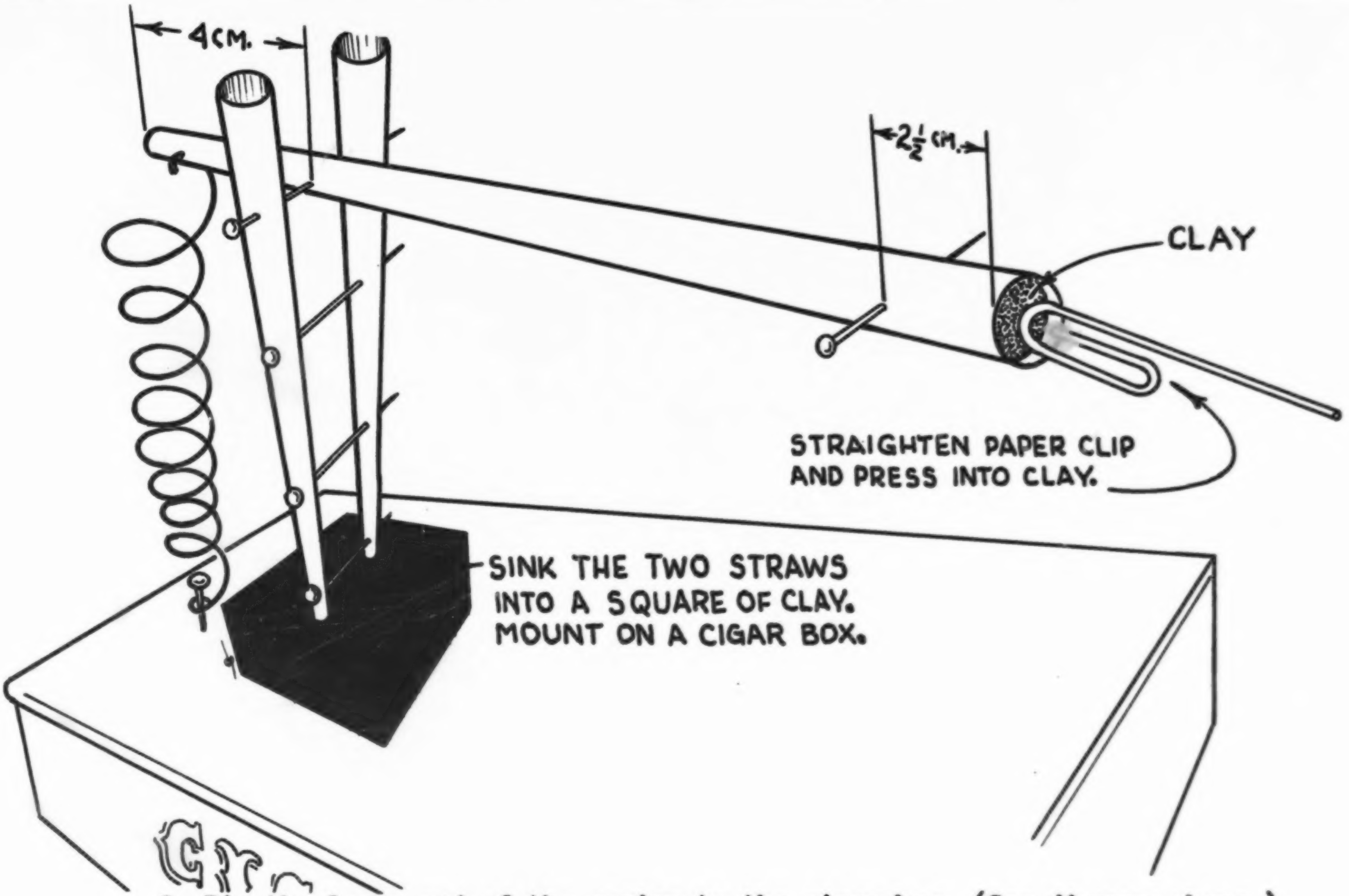
4. Using the top of your cigar box and some clay to hold the straws upright (straight up and down) mount the straws near the edge of the cigar box.

5. Straighten out a paper clip. Fill one end of a soda straw with clay and stick the straightened paper clip in it to make a pointer.

6. Attach the tempered spring that you made yesterday to the other end of the pointer. (Make a small hole in the end of the pointer and put the wire through it.)

7. Make a mark 4 centimeters from the end of the pointer that has the spring. This is where you will attach the pointer to the pointer holder.

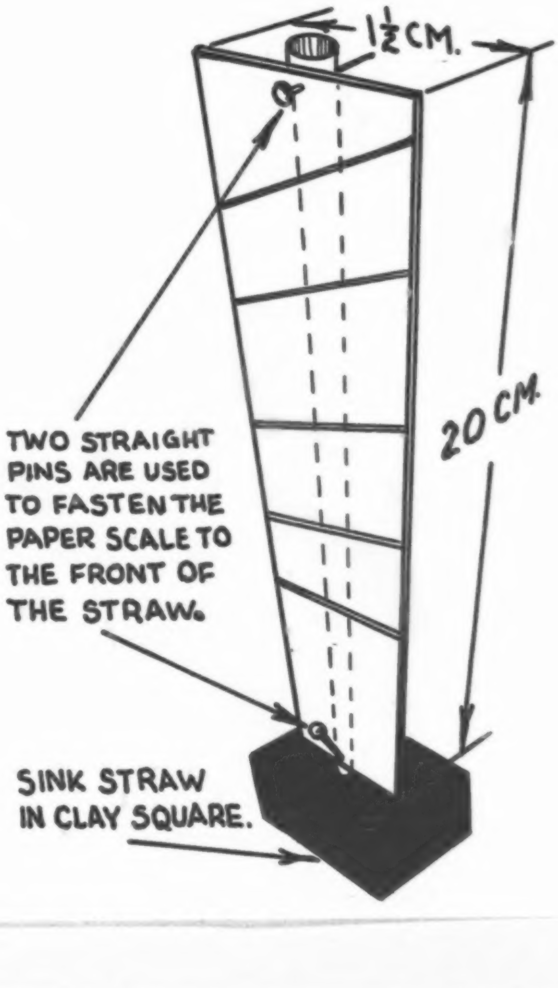
8. Attach the pointer to the pointer holder with a straight pin. After you have attached them move them back and forth several times so that they move easily.


4 CM.
2½ CM.
CLAY
STRAIGHTEN PAPER CLIP AND PRESS INTO CLAY.
SINK THE TWO STRAWS INTO A SQUARE OF CLAY. MOUNT ON A CIGAR BOX.
Cig

9. Pin the loose end of the spring to the cigar box. (See diagram above.)

10. Measure 2½ centimeters from the end of the pointer and stick a pin through the straw at this point. BE SURE THAT THE PIN IS PUT THROUGH LEVEL WITH THE FLOOR. This will be used to hold the things you are going to weigh.

11. Pin the paper strip to your last soda straw (two pins are enough, one at the top and one at the bottom). Put a lump of clay on the bottom of this straw so that you will be able to stick it to your cigar box.


1½ CM.
20 CM.
TWO STRAIGHT PINS ARE USED TO FASTEN THE PAPER SCALE TO THE FRONT OF THE STRAW.
SINK STRAW IN CLAY SQUARE.

12. Gently push down on the pointer of your scale until it is in a horizontal (level) position. Put the straw with the paper on it on the cigar box so that the end of the straw itself comes just to the edge of the paper strip (the pointer should cross the strip of paper).
You have just built a real spring scale..... tomorrow you will find out how to use it to weigh the button, paper clip, cork, and nut whose weight you estimated in yesterdays lesson. Be careful with your scale, it is not for weighing heavy objects. The teacher will collect your scales and give them back to you for the next lesson. Make sure that your name is on your scale.

HOMEWORK:

1. Why can't the scale that you built weigh heavy objects?

2. Draw a picture of a scale that could be used for heavy objects.

3

MEASUREMENTS AND ENERGY IN PHYSICS

A. MEASUREMENTS

LESSON 7. Why can your spring scale be used to weigh small objects?

OUTCOMES:

In a spring scale the stretch of the spring is directly proportional to the weight placed on the scale.

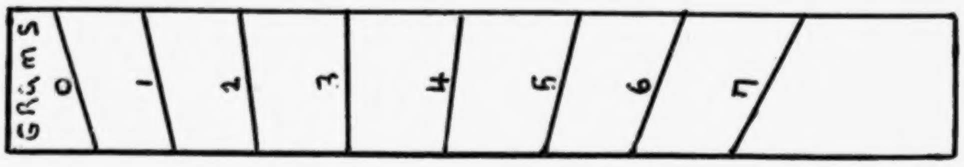
MATERIALS:

(Same for Teacher and Pupil)

spring scale constructed in previous lesson
set of seven one gram washers (from lesson 5)
assorted small objects to be weighed, including; the cork, button, paper clip, and steel nut (from lesson 5)
felt tip pen, magic marker, or soft pencil
ruler calibrated in centimeters
(teacher only) triple beam balance

PROCEDURE:

1. Distribute pupil worksheet and supplies.
2. If the pupils have taken their scales apart, have them reassemble them.
3. Encourage the pupils to place different combinations of washers on their scales and observe the results (the pin near the end of the pointer is for holding the washer).
4. Elicit from the class the observation that for each one gram washer that is placed on the scale, the pointer dips the same distance.
5. Have the pupils make the position of the pointer at 0 to 7 grams on the paper. The results should look something like this;



6. Have the pupils place the small objects of unknown weight on their scale. Ask them to observe the position of the pointer and to record the weight in grams of each object on their worksheets.

7. Elicit from the class that the scale works because the spring stretches the same amount for each gram of weight. A physicist named Hooke discovered this and it is called Hooke's Law.

8. Using the triple beam balance find the weight of the cork, paper clip, and steel nut. Write these on the blackboard so that the pupils may verify the accuracy of their scales.

9. Develop with the class in a short discussion that to find the weight of an object the best method is to use a scientific instrument, such as the scale. The least accurate method is to try to guess the weight by lifting the object.

10. If time permits, discuss with the class the reasons for the inaccuracy in their scales. Some reasons might be friction in the moving parts and inaccurate marking of the scale.

SUMMARY:

In a spring the amount of stretch is the same for each gram of weight added.

HOMEWORK:

Answer the questions on the pupil worksheet.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 7. Why can your spring scale be used to weigh small objects?

MATERIALS:

spring scale constructed in lesson 6
set of seven one gram washers (from lesson 5)
assorted small objects to be weighed, including the cork, paper clip, button, and steel nut (from lesson 5)
felt tip pen, magic marker, or soft pencil
centimeter ruler

PROCEDURE:

1. Reassemble the scale you made in the last lesson.

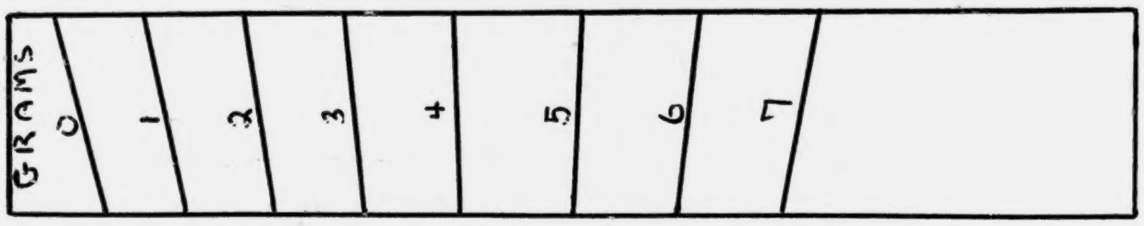
2. Take your one gram washers and place them on the holder of your scale one by one.

3. What do you observe as you add more weight to your scale?

   ____

   ____

4. Mark on the paper strip the place where the pointer of the scale stops for 0 to 7 grams (your washer weighs one gram). When you have finished your paper strip will look something like this:



5. Fill in the following table of observations as you do your experiments.

   a. Estimate the weight of the objects. (Remember you did this once before in lesson 5.)
   b. Weigh the objects on your own scale (the teacher will show you how to do this).
   c. The teacher will weigh the same objects on a laboratory scale and write their weights on the blackboard. Copy this information on your TABLE of OBSERVATIONS.

Table of Observations

Object	Estimated Weight	Weight on Homemade Scale	Weight on Teacher's scale
washer			
cork			
steel nut			
paper clip			
button			

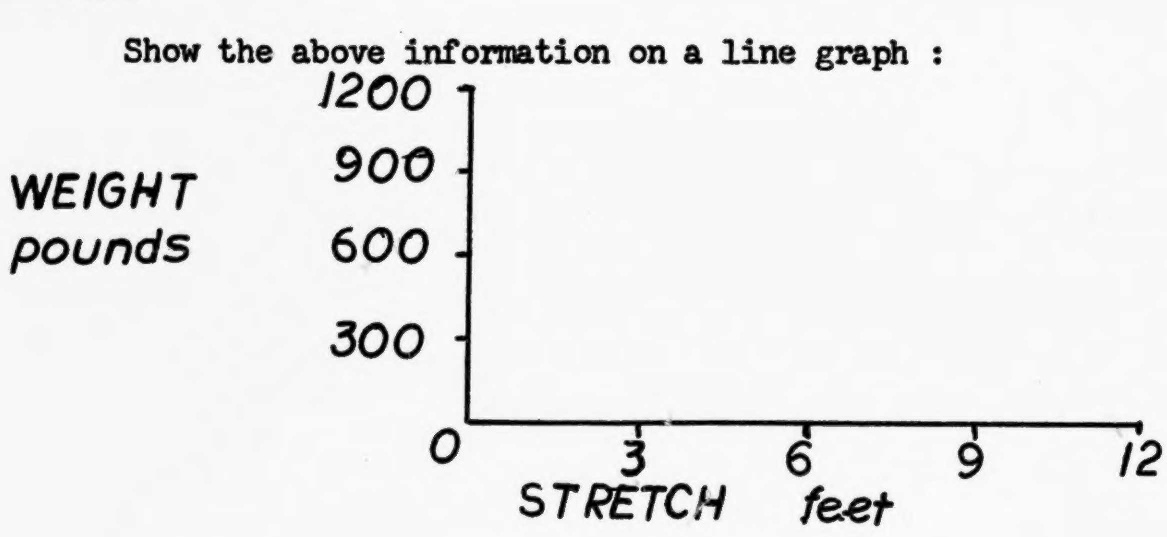
HOMEWORK:

If 600 pounds stretch a spring 6 feet, how far will the following weights stretch it?

Weight	Stretch
600 lbs.	6 feet
300 lbs.	
1200 lbs.	
900 lbs.	
0 lbs.	

EXTRA CREDIT:

Show the above information on a line graph :



B. ENERGY

LESSON 8. Where do forces come from?

OUTCOMES:

1. A force is a push or a pull.
2. Forces may be divided into:
    - a. electrical forces
        - (1) static-electric force
        - (2) electro-magnetic force
    - b. gravational forces
    - c. mechanical forces

MATERIALS:

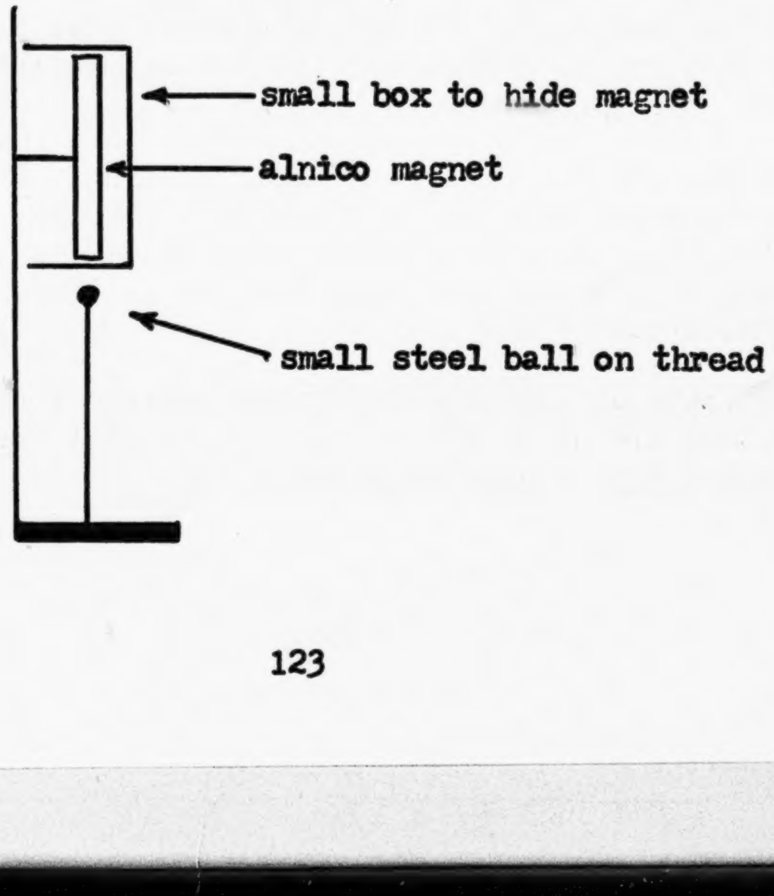
Teacher

alnico magnets (2)
small steel ball
electro-magnet
light weight aluminum foil
wooden matches
iron stand with clamp
paper clip
thread
rubber rod or comb
small piece of fur
candle

PROCEDURE:

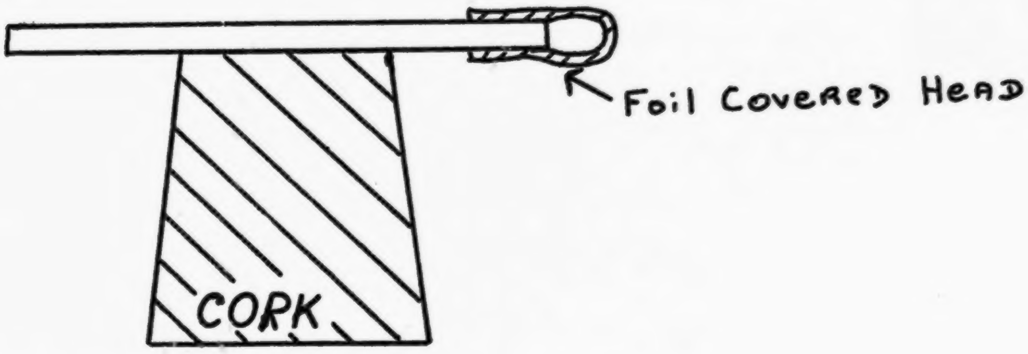
1. Distribute the pupil worksheets.

2. Set up the following demonstration and challenge the class to explain why it works; (allow them to examine it)



3. Tie a small steel ball to the clamp on an iron stand. Burn the thread holding the ball. Allow the class to explain what happened and enter their findings on their worksheets.

4. Construct a match stick rocket by wrapping the head of a wooden match with aluminum foil. When the head of the match is heated with a candle the match will ignite and the match will be propelled in the same fashion as a rocket ship. Place the match on a support such as a cork when performing this demonstration.
CAUTION: DO NOT ALLOW ANY PUPILS DIRECTLY IN FRONT OR IN BACK OF THE ROCKET IT WILL MOVE VERY RAPIDLY.
Have the class explain where the force came from and enter their findings on their pupil worksheets.
(OPTIONAL - To be done only with protective plastic shielding.)



5. Have a pupil rub a rubber rod or hard rubber comb with a piece of fur and use the rod to pick up small bits of paper. Have the class recall that this is static electricity; and enter their findings on their worksheets.

6. Encourage the class to give other examples of forces, and to find the origin of these forces. List them on the blackboard and have the class list them on their worksheets.

7. In a discussion, elicit from the class that a force is either a push or a pull. Review all the forces mentioned and label each as either push or pull.

8. Guide the pupils in tracing their origins. Lead the group to the generalization that a force may be due to any of the following: electricity, magnetism, gravity or mechanical. (In mechanical, include all forces from such sources as wind, water, engines, rockets, motion, etc.)

9. Demonstrate an electro-magnet and explain that since electricity and magnetism are so closely connected we call forces due to either one of them electro-magnetic forces.

10. Have the class look over their notes and be sure that all their forces are labeled as to push or pull and origin.

SUMMARY:

From their worksheets have the pupils answer the following questions:

a. What is a force?
b. Ehat kind of forces are there?

HOMEWORK:

See pupil worksheet.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 8. What is a force and where does it come from?

Demonstration or Experiment	Where the force came from (type of force)	Push or pull

HOMEWORK:

1. What are the three types of force?
   a.
   b.
   c.

2. Give an example of each type of force. Explain where it comes from and whether it is a push or a pull.

B. ENERGY

LESSON 9. How is force measured?

OUTCOMES:

1. Forces may be measured with a spring scale.
2. In the metric system force is measured in grams.
3. In the english system force is measured in pounds and ounces.

MATERIALS:

spring scales calibrated in grams and pounds
several assorted threads

PROCEDURE:

1. Distribute the pupil worksheets.

2. Ask the class if they ever wondered how strong the thread was that women used for sewing, or how strong the string was that is used to tie up small packages. Rephrase this so as to pose the question, "How much force (pull) is necessary to break a string or thread?" Spend a few minutes discussing why this knowledge is important. Cite such examples as fishing line, anchor ropes for boats, and the belts that window cleaners wear on high buildings.

3. Challenge the class to find a way to measure the force necessary to break a string, thread, etc.

4. Distribute a spring scale and several samples of thread to each member of the class. Challenge them to find the breaking strength of the threads. As they test the different threads they should enter their findings on their worksheets. Encourage the class to use the metric system in making measurements.

   Note: The measurement is best performed by tying the thread to the end of the scale, and while watching the pointer, carefully pulling on the thread until it breaks.

5. After the class has measured the force necessary to break the string, explain that 454 grams equal one pound, and that about 28 grams equal one ounce. It may be necessary to review the fact that 16 ounces equal one pound.

6. Using the breaking strength data from different members of the class demonstrate the method of changing grams into pounds and ounces.

SUMMARY:

Have the class answer the summary questions on their worksheets. A short discussion of the fact that force may be measured in different units would be worthwhile.

HOMEWORK:

Have the class change all their measurements from grams into pounds and ounces.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 9. How strong is a string?

MATERIALS:

spring scale calibrated in grams
several assorted threads

PROCEDURE:

Find a way to measure the breaking strength of the different threads. Record your findings in the table of observations.

TYPE OF THREAD	BREAKING STRENGTH		
	GRAMS	OUNCES	POUNDS

SUMMARY QUESTIONS:

1. What is the name of the instrument used to measure force? ____________

2. How many grams are there in one pound? ____________ = one pound

3. About how many grams equal one ounce? ____________ = one ounce

4. What units are used to measure force in this experiment?
   a.
   b.
   c.

B. ENERGY

LESSON 10. How is work measured?

OUTCOMES:

1. Work is done when a force is used and something moves.
2. In the metric system, work may be expressed as gram centimeters.
3. In the english system work may be expressed as foot pounds.

MATERIALS:

Teacher

spring scale calibrated in grams and pounds
a one pound weight (if none is available a sufficient number of lead fishing sinkers may be used)
gram weights of 100 and 200 grams
ruler calibrated in feet and centimeters

PROCEDURE:

1. Distribute pupil worksheets.

2. Have a pupil perform the following demonstration: push a chair across the room, push on the wall. Raise the question, "What was the same about the two actions and what was different?" The elicited response should be, in the first case, something was pushed and it moved. In the second case, something was pushed and it did not move. Remind the class that a push or a pull is called a force. Using the term force, guide them to understand that in the first case a force was used and the object moved, and in the second case a force was used but nothing moved. Have them enter their observations on their worksheets.

3. Explain to the class that according to the laws of physics, in the first case work was done but in the second case no work was done. Have the class enter this observation on their worksheets.

4. Show the pupils the proper way to use the formular for work: $W=Fd$ (work equals force × distance moved). A good way to do this is to lift a one pound weight a distance of one foot. (Use a spring scale to lift the weight so that the force used to lift it may be actually measured). Write the following on the blackboard:

   F = Force used to lift object = 1 pound
   d = Distance object moved = 1 foot

   work = force x distance moved
   work = 1 pound x 1 foot = 1 foot pound

   Explain that since when we multiply feet by pounds we get an answer that is part force and part distance. We can remember this by calling it a foot pound.

5. Now have a pupil drag the same one pound weight across the table for a distance of one foot and record the reading of the scale. Have the class calculate the amount of work done as you solve the problem at the blackboard.

6. Repeat the dragging and lifting experiment using a 100 gram weight instead of the pound. Lift it 10 centimeters instead of 1 foot. Repeat the solution of the equation $W = F \times d$ using the new data. Develop the unit called the gram-centimeter using the same reasoning that was used for the foot - pound.

7. Raise the question to the class; Do you do more work on an object when you lift it or when you drag it? (This will lead to later lessons on simple machines)

SUMMARY:

It should be emphasized that for work to be done a force must be used and something must move. Have the class recall the demonstration of the pupil pushing the chair and the wall to illustrate the idea.

HOMEWORK:

Have the class complete their worksheets.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 10. Are you working?

PROCEDURE:

1. Watch the demonstration that the pupil is doing in front of the room. Enter your observations in the table below.

PUSH A CHAIR	PUSH A WALL

2. Two things must happen before work is done. What are they?

   a. ____________________ b. ____________________

3. When you multiply a foot and a pound you get a ______________.

4. When you multiply a gram and a centimeter you get a __________.

5. You push a car for 10 minutes but it does not move.

   Have you done any work? ______________ Why? ____________

   ____

6. If you lift a one pound weight straight up how much work do you do? ______________________________

7. If you lift a 100 gram weight 10 centimeters straight up, how much work do you do? ______________________

8. Is it harder to lift a car or push a car? __________

9. Is it more work to lift a car or to push a car? Why?

____

____

____

B. ENERGY

LESSON 11. Why was the wheel invented?

OUTCOMES:

1. Much of the work done in pulling an object is used to overcome friction.
2. Two important factors that determine the amount of friction are:

   a. the type of surface
   b. whether the object is rolling

MATERIALS:

Pupil

spring scale calibrated in grams
Hall's carriage (small cart with wheels) S-1 # 14-0388.01
sandpaper sheet longer than 10 centimeters
meter stick
string

PROCEDURE:

1. Distribute pupil worksheets and all materials.

2. Challenge the class to solve the problems on the worksheets without help. (Since some may require help, walk around the classroom and help these pupils individually.)

3. After the class has finished parts 1 through 5 of the investigation, a short discussion of the results will help them formulate their ideas. The word "friction" should be used frequently in this discussion.

4. Instruct the class to complete part six of their worksheets.

SUMMARY:

The summary should emphasize the role of friction in using up work. The two important factors affecting friction, surface and rolling, should be stressed.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 11. Why was the wheel invented?

MATERIALS:

Hall's carriage (small cart with wheels)
full sheet of sandpaper
spring scale
meter stick
string

PROCEDURE:

1. Take the "Hall's Carriage" and turn it upside down, attach the spring scale to it and drag it 10 centimeters across the table. Using the formula for work (Work = Force x Distance) find how much work you did. Remember the force you use can be found by reading the scale as you move the cart. Do your experiments in the metric system using grams for force and centimeters for distance.

   Force = ____________________

   Distance Moved = __________________

   Work = Force x Distance Moved = __________x__________= ___________

2. Using the same cart upside down drag it 10 centimeters over the sandpaper. Find out how much work you did.

   Force = ____________________

   Distance Moved = _________________

   Work = ____________x____________=__________

3. Turn the cart right side up and roll it 10 centimeters over the desk. Find the work done.

   Force = _________________

   Distance Moved = _______________

   Work = _______________

4. Using the cart right side up roll it 10 centimeters over sandpaper. Find the work done.

   F = ____________ D = _______________ W = ________________

5. Summarize your experiments in the table of information below.

Surface	Rolling or Sliding	Work done

6. Based on the table you have just made answer these questions:

a. In general on which surface is the least amount of work done?

________________________ Why? ____________________________________

____

b. On which surface is the greatest work required to move an object?

________________________ Why? ____________________________________

____

c. Is the friction higher on the table or on the sandpaper? ________

Why? ____

d. Is it more work to roll an object or to drag it? ______________

Why? ____

B. ENERGY

LESSON 12. What happens to energy after it is used?

OUTCOMES:

1. Energy comes in many forms.
2. Energy changes from form to form but is never created or destroyed.

MATERIALS:

Teacher

hand operated generated with attached bulb
test tube with loosely fitted cork
test tube holder
bunsen burner

PROCEDURE:

1. Distribute the pupil worksheets.

2. Challenge the class with the following question: "After a basketball game you have used up a lot of energy, what has happened to that energy?" During the class discussion of the problem, the need for knowing the different forms of energy should arise. The following forms of energy should be elicited from the class and listed on the blackboard:

   a. electrical
   b. chemical
   c. heat
   d. light
   e. sound
   f. atomic or nuclear
   g. mechanical

   When the class gives an example of energy instead of the type of energy fill that in as an example.

3. After all the forms of energy have been elicited, do the following demonstration; put about ½ inch of water in a test tube and close it with a loosely fitting cork. Heat the test tube until the cork pops out. With the class, trace the energy changes that have taken place. A diagram of the demonstration with the energy changes clearly labeled is a good method for keeping track of the energy changes.

4. By pointing to the diagram and repeatedly asking the question where did this energy go (referring to different parts of the diagram each time) the concept of changing forms of energy will develop.

5. After the class has developed the concept that energy may change in form ask the key question, "Where have all the forms of energy come from?" The reply should indicate that they all come from some other form of energy.

6. Based on this discussion and demonstration, a formal statement of the law of conservation of energy should be elicited. "Energy cannot be created or destroyed, it can only be changed in form." To aid to the understanding of this idea the following types of questions migh be asked:

   a. Has any energy been added? (If the reply is yes, challenge the pupil to show you where.)

   b. Has any energy been lost?

   c. Have we lost track of any of the energy?

SUMMARY:

Quickly review the test tube and cork demonstration. Encourage the pupils to state the physical law that this illustrates.

HOMEWORK:

Demonstrate the hand operated generator. Challenge the class to write up how it illustrates the law of conservation of energy.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 12. What happens to energy after it is used?

PROCEDURE:

1. List the different forms of energy and give an example of each.

FORM OF ENERGY	EXAMPLE

2. Show the energy changes in the test tube and cork demonstration.

B. ENERGY

LESSON 13. Energy - Before and After

OUTCOMES:

1. Stored up energy is known as potential energy.
2. Energy, due to the motion of an object, is known as kinetic energy.

MATERIALS:

Teacher

12 inch ruler
2 ring stands and clamps
string
friction matches
clay
2 meter sticks
4 clothespins
sandpaper (coarse)
ball

Pupil

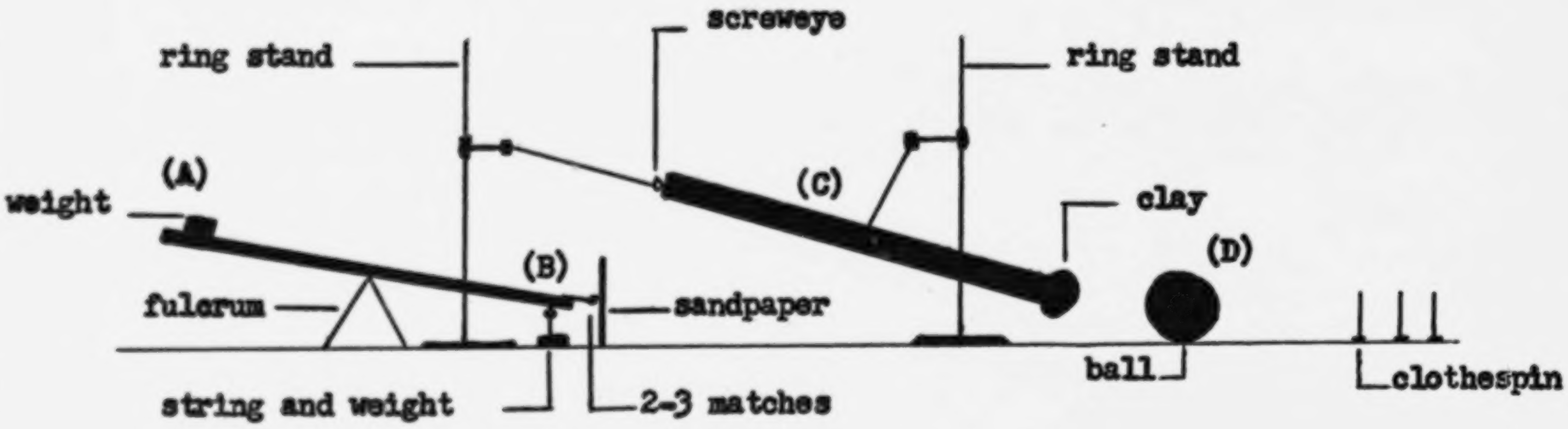
matches
tongs
peanut
asbestos square
hammer
nail
block of wood

PROCEDURE:

1. Place a pencil under a ruler so that one end of the ruler is raised from the table. Put a penny on the end touching the table. Ask a pupil to hold a book over the raised end. Ask, "What can happen to the book?" Ask the pupil to drop the book. From the above, have the pupils realize:

   a. The penny was moved therefore work was done.
   b. The book supplied the energy required.
   c. The raised book represented stored or potential energy.
   d. The falling book represented energy in motion or kinetic energy.

2. Set up the demonstration as shown in the diagram below.


screweye
ring stand
ring stand
(A)
weight
(C)
clay
(D)
(B)
fulcrum
sandpaper
ball
clothespin
string and weight
2-3 matches

NOTE: To start into motion,cut the string attached to the weight. The stick will fall on one end causing the matches to ignite against the sandpaper on the other end. The matches will burn through the string, releasing the stick, causing it to strike the ball, which in turn will bowl over the clothespins.

Before the apparatus is set into motion, question the pupils as to where they will find objects which show potential energy (A, B, C, or D). Ask them to describe how these objects will exhibit kinetic energy.

3. Distribute pupil worksheets.

NOTE: Any food which will burn may be substituted for the peanut.

SUMMARY:

Summarize by displaying or describing several items in various states of rest or motion. Ask the pupils to state if the objects are exhibiting potential or kinetic energy.

HOMEWORK:

See pupil worksheet.

REFERENCES:

1. Kahn, Greenleaf, Groffman, and Kanderer, Investigating Science 8, Syracuse, New York, L.W. Singer.

2. Brooks, Tracy, Tropp, and Friedl, Modern Physical Science, New York, Holt, Rhinehart, and Winston.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 13. How do we use potential and kinetic energy everyday?

MATERIALS:

matches
tongs
peanut
square of asbestos
hammer
nail
block of wood

PROCEDURE:

1. Examine the peanut. Does the peanut have potential energy? ________

   How? ______________________________

2. Examine the match. Does the match have potential energy? ________

   How? ______________________________

3. Strike the match. Is this kinetic energy? ________________

   How do you know? ______________________

4. Pick up the peanut with the tongs. Hold the match under the peanut.

   CAUTION: Make sure you hold the peanut over the asbestos square.

   What is happening to the peanut? ________________

   Is this kinetic energy? ______________________

   When can a peanut cause something to move? ____________

5. Hammer the nail into the wood. When does the hammer have potential energy? ______________________________

   When does the hammer have kinetic energy? ____________

   ____

HOMEWORK:

Answer the following questions at home. We make use of potential and kinetic energy everyday. In the following things we do, find the potential and kinetic energy. For example, throwing a ball.

	Potential energy	Kinetic energy
throwing a ball	raising the ball	the moving ball
turning on a phonograph		
cooking soup		
riding a bike		
turning on a faucet		
playing with a yo-yo		

B. ENERGY

LESSON 14. Do pulleys give us something for nothing?
(Note: This lesson may require two periods for completion.)

OUTCOMES:

1. A pulley system can increase the force that you exert.
2. When a pulley system increases the force exerted on an object it decreases the distance the object moves.

MATERIALS:

Teacher and Pupil

iron stand with attached clamp
2 single pulleys
string
spring scale (0-250 grams)
2 meter sticks
weight (200 grams)

Note: For best results the pupils should cooperate in groups of two.

PROCEDURE:

1. Before the class begins set up a model of the single fixed pulley, the single moveable pulley, and the single fixed-single moveable pulley system.

2. Distribute the pupil worksheets and the materials.

3. Encourage the class to solve the problems on their pupil worksheets. although it is most desirable that the children work independently it may be necessary to assist some pupils in setting up the more complicated pulleys.

4. After the class has completed taking their data and completed their table of observations, allow them about five more minutes to answer questions 5 - 8 on the worksheets. Now place a set of typical data on the blackboard and have questions 5 - 8 answered by members of the class. Encourage discussion of the results.

SUMMARY:

The class discussion of questions 5 - 8 should lead to the summary of this lesson.

HOMEWORK:

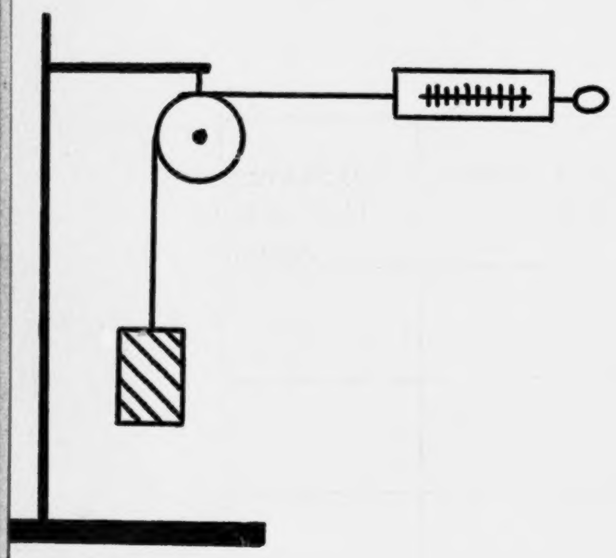
List all the ways that you could use a pulley system to help you build a house.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

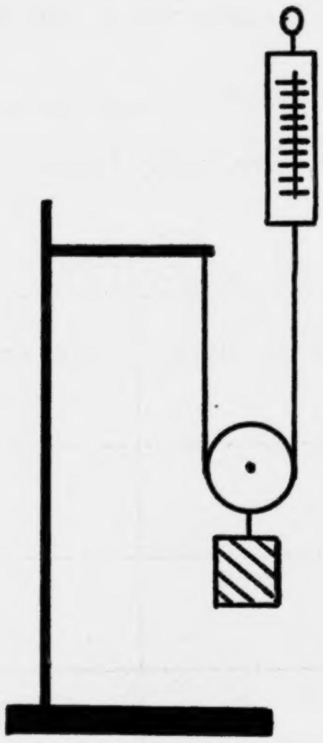
LESSON 14. Do pulleys give us something for nothing?

MATERIALS:

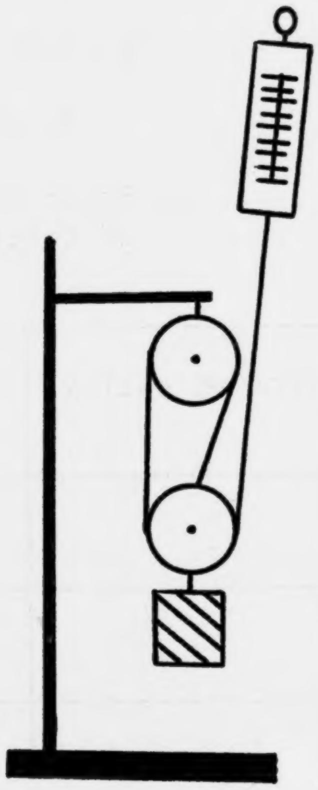
iron stand with clamp
two single pulleys
string
spring scale (0-250 grams)
two meter sticks
weight (200 grams)



single fixed pulley



single movable pulley



single fixed single movable pulley system

PROCEDURE:

1. Set up the single fixed pulley with a 200 gram weight.
   - a. How much force is needed to lift the 200 gram weight?

     Force = ________________grams
   - b. How far does the weight move when you move the spring scale 20 centimeters? Distance = ______________centimeters

2. Set up the single moveable pulley with a 200 gram weight.

   a. How much force is needed to lift the 200 gram weight?

      Force = ________________grams

   b. How far does the weight move when you move the spring scale 20 centimeters? Distance = ________________centimeters

3. Set up the single fixed-single moveable pulley system. Hook a 200 gram weight to the bottom pulley.

   a. How much force is needed to lift the 200 gram weight?

      Force = ________________grams

   b. How far does the weight move when you move the spring scale 20 centimeters? Distance = ________________centimeters

4. Enter all the things that you have found out so far in the table of observations below.

TABLE OF OBSERVATIONS

type of pulley	weight lifted	force used	distance you moved the scale	distance the weight moved

5. Use the table of observations that you have just made to answer the following questions:

   a. What happened to the force needed to lift the 200 gram weight as you used different types of pulleys? ________________________

      ____

      ____

      ____

b. What happened to the distance the 200 gram weight moved as you used different types of pulleys? ______________________

____

____

____

c. Do pulleys give "something for nothing"? ______________

____

____

d. What do you give up to increase the force in a pulley system?

____

____

EXTRA CREDIT

Remember that WORK = FORCE X DISTANCE

1. How much work did you do in lifting the 200 gram weight in each pulley system? How much work was done on the weight?

type of pulley	work you did	work done on the weight

2. Can you ever get more out of a pulley system than you put in?

__________________________ Why? (HINT: Remember conservation of energy)

____

____

____

B. ENERGY

LESSON 15. Why is it easier to roll a piano up a ramp than to lift it up a flight of stairs?

OUTCOMES:

1. The inclined plane decreases the amount of force needed to lift an object.
2. The mechanical advantage of a machine tells us how many times it multiplies the force.

MATERIALS:

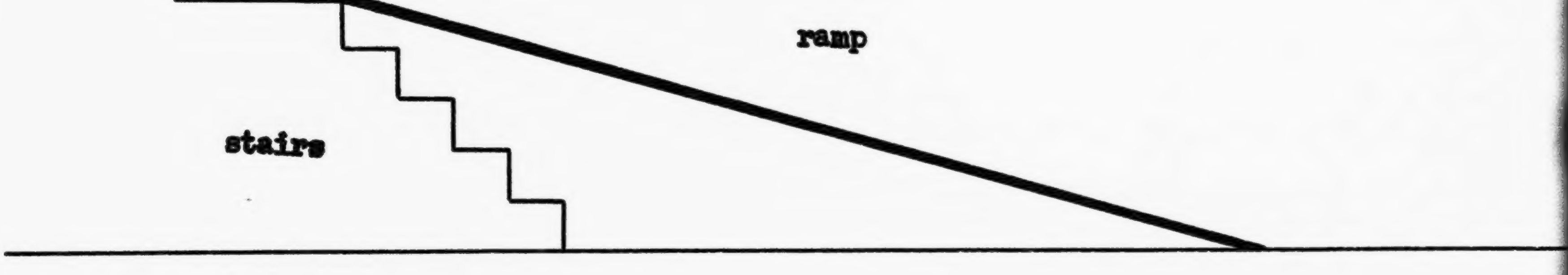
inclined plane (smooth board about one meter long)
iron stand with clamp to support the inclined plane
Hall's carriage (small cart with wheels)
200 gram weight
spring scale (0 - 2000 grams)
string
meter stick
heavy book

NOTE: For this lesson the pupils should work in groups of two.

PROCEDURE:

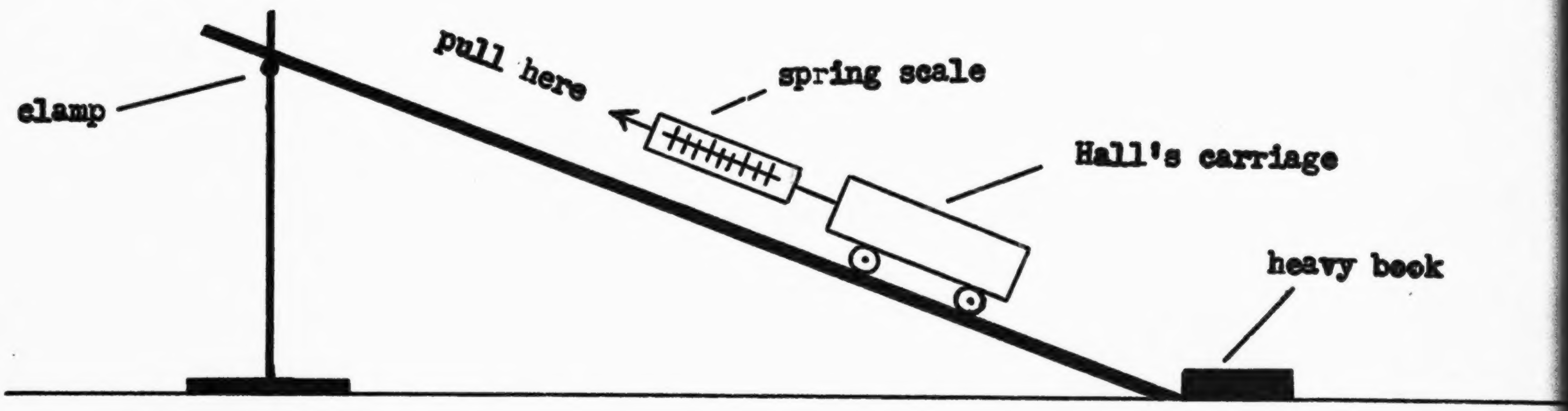
1. Distribute pupil worksheets.

2. Discuss with the class the relative advantages of rolling a piano up a ramp and carrying it up a flight of steps. The following type of diagram may prove useful;



Encourage pupils to conclude that in both cases the piano is lifted to the same height.

3. Distribute the materials and encourage the class to solve the problems on the worksheet. Walk around the room illustrating the proper method for measuring the force on the inclined plane.



4. When the class has finished their measurements, stop for a moment and read over together part 7 of the worksheet. Take the data from from one group of pupils and show on the blackboard how mechanical advantage is found. Allow about 10 minutes after this for the class to calculate the M.A. of their inclined planes.

SUMMARY:

Both the pulley system and the inclined plane are examples of simple machines. In every case when you increase the force that you exert you decrease the distance you move.

HOMEWORK:

Go back to lesson 14 and find the mechanical advantage of each of the pulley systems that you used. To find the M.A. of a pulley system you divide the weight you lifted by the force you used to lift it.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 15. Why is it easier to roll a piano up a ramp than to carry it up a flight of stairs?

MATERIALS:

- inclined plane (smooth board about 1 meter long)
- iron stand with clamp to support the inclined plane
- Hall's carriage (small cart with wheels)
- 200 gram weight
- spring scale (0 - 2000 grams)
- string
- meter stick
- heavy book

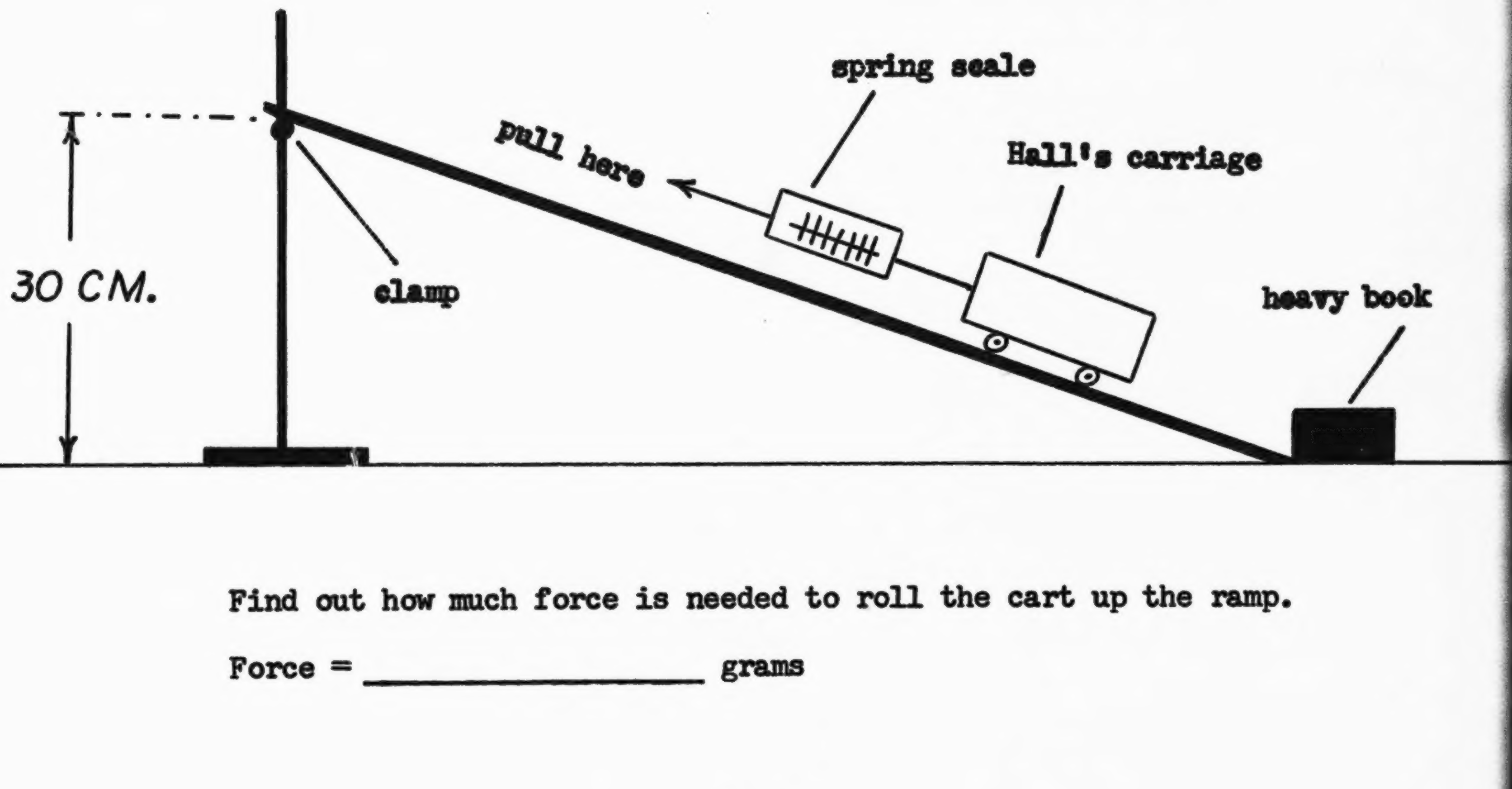
PROCEDURE:

1. Because it would be impractical to experiment with rolling and lifting a piano in the following experiments use Hall's carriage to take the place of the piano. To make it extra heavy, place a 200 gram weight in it.

2. Hook the 200 gram weight to the carriage and find the amount of force needed to lift it straight up in the air, just as you would do if you were carrying it up a flight of stairs.

   Force = ________________ grams

3. Using the equipment, set up a ramp similar to the one in the diagram below.

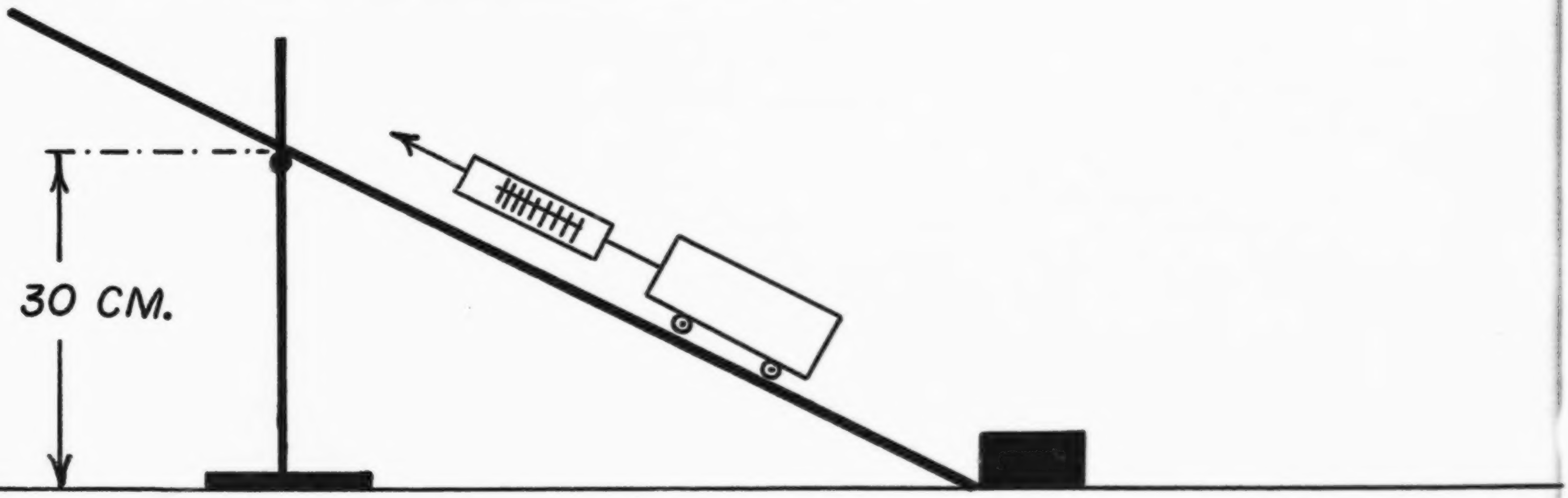


Find out how much force is needed to roll the cart up the ramp.

Force = ________________ grams

4. Make the ramp a little steeper by sliding the board up about 20 centimeters. Find the force needed to move the cart now.

   Force = ______________________ grams



5. Slide the board up another 20 centimeters. Measure the force again.

   Force = ____________________ grams

6. When you make the ramp steeper, what happens to the amount of force

   needed to move the cart? ____________________________________

   ____

7. When an engineer builds a ramp to make lifting easier he wants to know how much help the ramp will give him. He measures the amount of help he gets by finding something called the mechanical advantage, or M.A. The M.A. tells you how many times the ramp multiplies the force you use. For example, if a piano weighs 1000 pounds and you can move it on a ramp with a force of 500 pounds you have a M.A. of 2. If you could move the piano with a force of only 100 pounds you would have a mechanical advantage of 10.

8. By dividing the force needed to lift the cart by the force needed to move it on the ramp (inclined plane) find the mechanical advantage of the different ramps that you have used.

$$\frac{\text{force needed to lift the cart}}{\text{force needed to move the cart on the ramp}} = \text{mechanical advantage}$$

   a. __________________ =

   b. __________________ =

   c. __________________ =

9. What happens to the mechanical advantage of a ramp as you make it steeper? ______________________________

____

____

B. ENERGY

LESSON 16. Can you lift a car?

OUTCOMES:

1. A lever is a rigid bar supported at a point around which the bar can turn.
2. To get a lever to function properly, the distance between the effort and the turning point must be greater than the distance between the resistance and the turning point.

MATERIALS:

Teacher

several textbooks
12 inch ruler
pencil
several instruments which are levers (scissors, pliers, etc.)

Pupil

book
12 inch ruler
pencil

PROCEDURE:

1. Stack 5 textbooks on the desk. Ask a pupil to place his little finger under the books and to lift them. Ask him to describe the effort it required.
2. Insert a 12 inch ruler about 2 inches under the books. Place a pencil under the ruler, close to the books. Ask the pupil to use his pinky and press on the free end of the ruler. Ask him to describe the effort it required.
3. State, "The books were lifted by using a simple machine called a lever.
4. Hold up the ruler, and ask, "What is one thing we need to make a lever?" (Establish that one item must be a rigid bar.)
5. Display the pencil, rock the ruler on the pencil. Ask, "What is the second item we need in order to make a lever?" (A point around which the bar will turn.)
6. Set up the lever again and say, "Since the bar and turning point alone are not enough to move an object, what else is needed?" (a force)
7. Distribute pupil worksheets. Read the questions to the pupils and have them react before they proceed.

8. To reinforce the pupil activity, ask a pupil to go to the front door of the classroom and perform the following: Using one finger placed on the door above the door knob, open the door. Most of the pupils will recognize the turning points and should realize that as one goes further away from the turning point, the effort required to move the weight becomes less.

SUMMARY:

1. What would you need to lift a car?
2. Name some levers that are used everyday. (car jack, wheelbarrow, forearm, crowbar, plier, seesaw) Display some lever-type tools.

HOMEWORK:

See pupil worksheet.

REFERENCE:

Kahn, greenleaf, Groffman, and Kanderer, Investigating Science 8, Syracuse, New York: L.W. Singer

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 16. How can we make a lever work better?

MATERIALS:

book
12 inch ruler
pencil

PROCEDURE:

1. Place a book on your desk. Place a ruler 2 inches under the book. place a pencil under the ruler, near the book. Before going further, ask the teacher to check your lever.

2. Push on the end of the ruler. Did it require much effort? ___________

3. If you push more of the ruler under the book, should it be easier or harder to lift the book? _________________

4. Push about 6 inches of the ruler under the book and lift. Was it easier or harder to lift the book? _________________

5. Place about 10 inches of the ruler under the book and lift. What happened? ____

6. Write your observations on the chart below.

Length of ruler under book	Length of ruler from turning point	Effort (little, medium, strong, can't move)
2 inches		
6 inches		
10 inches		

7. How can you explain what happened? _________________________________

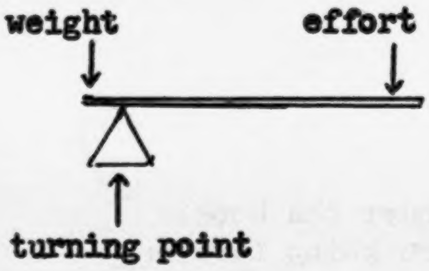
____

____

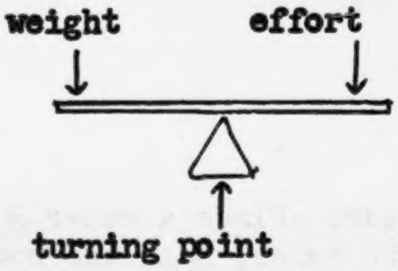
HOMEWORK:

Pick out the lever which will do the best job and explain why.

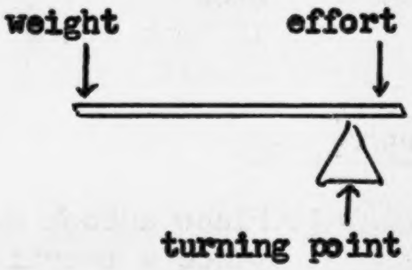
(A)


weight
effort
turning point

(B)


weight
effort
turning point

(C)


weight
effort
turning point

B. ENERGY

LESSON 17. Why do things turn?

OUTCOMES:

1. An object will balance if the monents of force on one side of the turning point equals the moments of force on the other.
2. An object will turn if the moments of force on each side of the turning point are unequal.

MATERIALS:

Teacher

meter stick
thumb tacks
equal arm balance

Pupil

4 washers
ring stand and clamp
meter stick
2 eight inch lengths of bell wire
1 right inch length of thread
1 twelve inch length of string

PROCEDURE:

NOTE: The purpose of the following steps is to establish the fact that in order for an object to turn:

1. A greater force must be placed on one side of the turning point.
2. If there are equal forces on both sides of the turning point, one force must be moved closer or further from the turning point.

1. Challenge a pupil to come to the front of the room and balance a meter stick on his finger.

2. Ask another pupil to read the number on the meter stick at the balance point. Ask, "Why does the stick balance at the mid-point?"

3. Shift the meter stick on the pupil's finger so that the 40 centimeter mark is over his finger. Ask, "Why doesn't the stick balance?"

4. Challenge the class to suggest a method of balancing the meter stick at the 40 centimeter mark.

5. Balance the meter stick using thumb tacks.

6. Balance a meter stick on the finger. Ask a pupil to place a thumb tack at the 40 centimeter and 60 centimeter marks. Demonstrate what happens if the thumb tack at the 40 centimeter mark is moved to the 35 centimeter or 45 centimeter positions.

7. Display pupil worksheets.

SUMMARY:

Summarize by displaying an equal arm balance and ask the pupils to explain the principle upon which it works.

HOMEWORK:

Explain how a boy weighing 130 pounds could raise a boy weighing 140 pounds, on a seesaw.

REFERENCES:

1. Brooks, Tracy, Tropp, and Friedl. Modern Physical Science, New York, Holt, Rhinehart, and Winston.

2. Baker, Brownlee, and Fuller. Elements of Physics, Rockleigh, New Jersey, Allyn and Bacon.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 17. How can we use a balanced object as a scale?

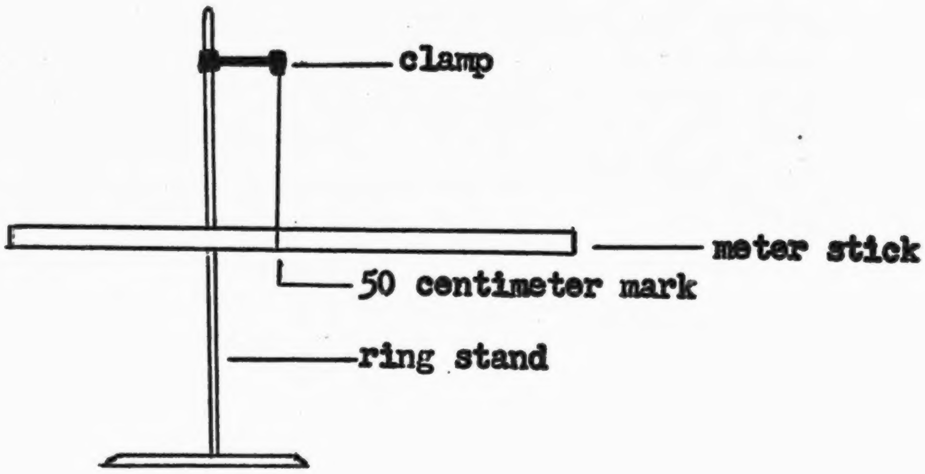
MATERIALS:

4 washers of equal weight
meter stick
ring stand
ring stand clamp
2 eight inch lengths of bell wire
1 eight inch length of thread
1 twelve inch length of string

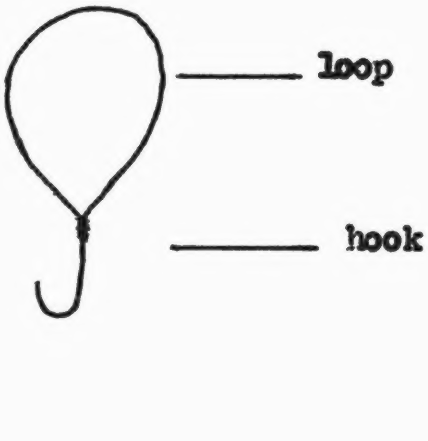
PROCEDURE:

1. Tie the 12 inch string to the balance point of the meter stick. (This should be at the   centimeter mark.)

2. Tie the other end of the string to the ring stand clamp. The set-up should look like the diagram below.



3. Make 2 loops out of the bell wire so that each loop fits on the meter stick. Leave one end longer and bend it into a hook. See diagram.



4. Place the loops on the meter stick at the 9 centimeter and 27 centimeter mark.

5. Place a washer on the hook at the 9 centimeter mark.

   What happens? ____

   Why? ____

6. Mark another washer 1 ounce. Place it on the hook at the 27

   centimeter mark. What happens? __________________________

   ____

   What is the weight of the first washer? __________________

   How do you know? ______________________________________

7. Place another washer on the first hook, and one on the second hook.

   What is the weight of the first two washers? _____________

8. Remove the loop and washers at the 27 centimeter mark. Remove one washer from the first hook. Tie the thread to a washer so that a loop forms. Place the loop on the meter stick at the 27 centimeter mark.
   What Happens? ____

   Why? ____

   What does this show? ___________________________________

   ____

B. ENERGY

LESSON 18. Why don't the South Americans fall off the earth?

OUTCOMES:

1. Gravitation is the mutual attraction between two bodies.
2. On the earth, the force which pulls objects towards it is known as gravity.
3. The closer one goes to the earth the stronger the attraction.

MATERIALS:

Teacher

2 foot string
small weight
guinea and feather apparatus
vacuum pump

Pupil

12 inch ruler

PROCEDURE:

1. Motivate the class by narrating the following story of Newton.

   As the story goes, Sir Isaac Newton was sitting in his garden when he noticed an apple falling from a tree. According to some sources this is when Newton cried out, "Eureka, I've discovered gravity." Of course, we know that a true scientist does not "discover" something so important in an instant. People knew that objects thrown into the air fell back to earth. What Newton did was to use the logic of clear, cool reason. He thought, "If I went to the top of a tall building and dropped the apple, it would fall to the earth. If I went to the top of a mountain and dropped an apple, it would fall to the earth. If I went into space and dropped the apple, it would fall to the earth. Therefore this gravitational attraction should extend out into space and involve all matter in the universe."

   A problem arose. If all bodies in the universe attract each other, why doesn't the earth fall into the sun?

2. Tie a two foot string to a small weight. Flip the string so that the weight lifts in the air and drops back into your hand. Ask the pupils to come up with a method of preventing the weight from dropping back. (Spinning the weight.) After performing the demonstration ask, "What caused the weight to turn in a circular path? How does this explain why the earth doesn't fall into the sun?"

3. Point out that a scientist named Galileo actually went further than Newton. He actually figured out how fast an object would fall due to gravity. He said that every object falls at the same velocity whether it's a piece of metal or a feather.

4. Display the guinea and feather apparatus. Point out the metal disk and the feather, and say to the pupils that you can make both objects fall to the bottom at the same time. Evacuate the air from the tube and demonstrate.

5. All the air to flow back in again and demonstrate. Ask, "Why doesn't the feather fall as rapidly when air is in the tube?"

6. Distribute pupil worksheets.

SUMMARY:

Summarize by asking a pupil to disclose how much he weighs, and to explain what causes the weight.

HOMEWORK:

See pupil worksheet.

REFERENCE:

Thurber and Kilburn. Exploring Physical Science, Rockleigh, New Jersey, Allyn and Bacon.

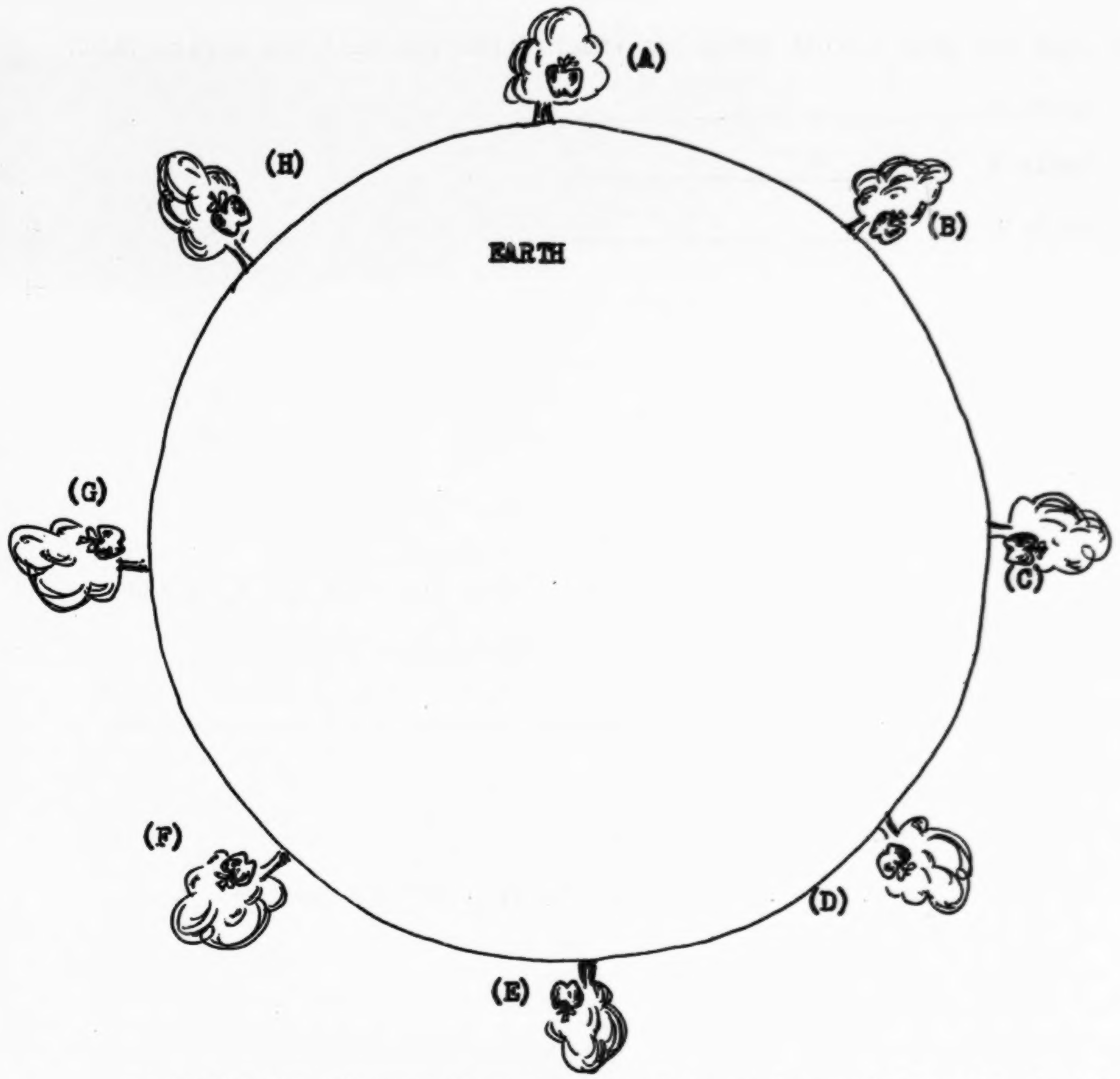
PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 18. Can something fall up?

MATERIALS:

12 inch ruler

PROCEDURE:



1. Study the diagram above, and next to each question write in the direction the apple will fall. (down, sideways, up)

Apple A ______________________________

Apple B ______________________________

Apple C ______________________________

Apple D ______________________________

Apple E ______________________________

Apple F ______________________________

Apple G ______________________________

Apple H ______________________________

2. Turn the page upside down. In which direction will the apples fall?

Apple A ______________________________

Apple B ______________________________

Apple C ______________________________

Apple D ______________________________

Apple E ______________________________

Apple F ______________________________

Apple G ______________________________

Apple H ______________________________

3. Using a ruler draw a straight line between apples A and E, B and F, C and G, and D and H.
   Where do all the apples appear to be falling to?

   ____

HOMEWORK:

1. Why do the apples seem to fall up?

2. Why don't the people in South America fall off the earth?

B. ENERGY

LESSON 19. Why do things tip over?

OUTCOMES:

1. The center of gravity is a point at which the entire weight of an object seems to be concentrated.
2. Objects tip over when the center of gravity is outside the base of the objects.

MATERIALS:

Teacher

5 textbooks of equal size
6 x 6 square of cardboard
straight pin or nail
wire clothes hanger
string
1 oz. fishing weight

Pupil

irregular shapes of cardboard
small nail
string
weight
ruler

PROCEDURE:

1. Place a textbook over the edge of a desk until the balance point is reached. Ask a pupil to measure the length of book which extends over the edge.

2. Challenge the class to extend the book at least two more inches over the edge.

3. Stack up the books as shown in the diagram. It should be obvious that the top book is much further over the edge. DON'T GIVE ANY EXPLANATION AT THIS TIME. If done carefully the top book may extend more than a full length over the edge.

4. Draw intersecting diagonals between the corners of a 6 x 6 inch square of cardboard. Stick a pin through the center of the square. Spin the cardboard and point out that it rotates around the center point. State that this is called the "center of gravity".

5. Place the pin off center and point out that the cardboard now "falls" in one direction.

6. Tie a weight to a wire hanger. Hook the hanger onto the belt of a pupil at the midline. Ask him to stand up straight and lean sideways. Point out what happens as the weight falls outside of the base created by his feet.

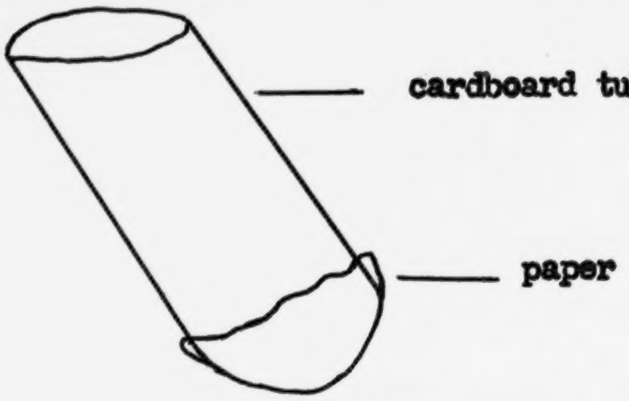
7. Distribute pupil worksheets.

SUMMARY:

Summarize by repeating the opening demonstration. Point out that stacking the books, the center of gravity of the books was shifted backwards. Therefore allowing the top book to extend very far over the edge of the desk.

HOMEWORK:

At home use an empty tube from a roll of paper towels or toilet tissue. Cut a round bottom on the tube as shown in the drawing. Cover the bottom with a piece of paper and attach with tape or a rubber band. Try to stand the tube straight up. What happens?



Place two tablespoons of salt into the tube. Try to stand it up. What happens? Why? Bring your project and answers into class for credit.

REFERENCES:

1. Sootin, H. Experiments with Machines and Matter. New York, W. W. Norton.

2. Gamow, G. Matter, Earth, and Sky, Englewood Cliffs, New Jersey. Prentice - Hall.

3. Baker, Brownlee, and Fuller. Elements of Physics, Rockleigh, New Jersey. Allyn and Bacon.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 19. How can we find the center of gravity of irregular objects?

MATERIALS:

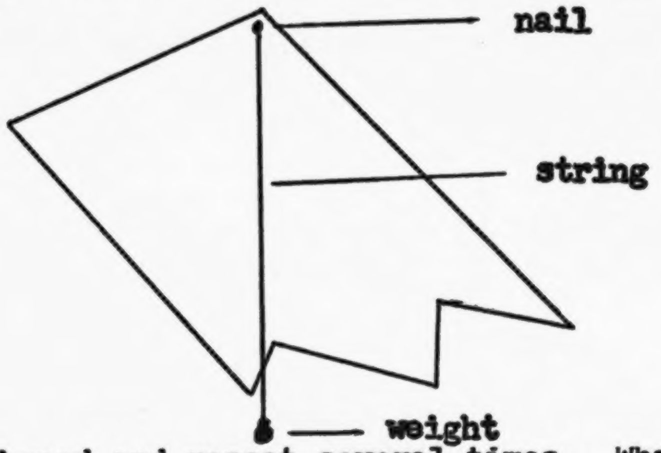
irregular shapes of cardboard
small nail
string
weight
ruler

PROCEDURE:

1. Push a nail through one corner of a cardboard. Move the cardboard back and forth until it swings freely.

2. Tie one end of the string to the weight. Make a loop on the other end.

3. Place the loop over the nail and by holding the nail lift the cardboard. Have your partner draw a straight line across the cardboard where the string hangs down. (See diagram.)
NOTE: This can be done easily by placing dots on the cardboard and connecting them when the cardboard is placed flat on the desk.



4. Turn the cardboard and repeat several times. What do we call the spot where all the lines cross?

____

C. DENSITY

LESSON 20. Why does metal feel heavier than wood?

OUTCOMES:

1. Objects of the same volume, but different composition, have different weights.
2. Density means the amount of material packed into a certain space.
3. The difference in weight between a piece of wood and a piece of iron of the same size is due to the density of the object.
4. The density is found by dividing the weight by the volume.

MATERIALS:

Teacher materials:
2 - 50ml Erlenmeyer flasks
50ml of Mercury
2 - 100ml beakers
test tube containing 5ml of Mercury
1,000ml Erlenmeyer flask
2 boxes of equal volume
ping-pong balls and marbles

Pupil materials:
Spring balance
Centimeter ruler
Four cubes (2x2x2cm) of the following: clay,polystyrene,wood,metal
Four 6" lengths of string

NOTE:

The Industrial Arts Department can be consulted for the construction of the wood and metal cubes. The cubes should measure 2cm x 2cm x 2cm.

PROCEDURE:

1. Label one 50ml Erlenmeyer flask A, and the other flask B. Fill flask A with water and flask B with mercury.
   (Caution: When using the flasks in the classroom, place them on a folded newspaper to reduce the possibility of cracking when they are lifted up and down.)

2. Call upon several students to come up to the teacher's desk to lift the flasks. Have them lift flask B first and then flask A. Ask them to explain why they think flask B was heavier. Allowing the pupils to use their own words in explaining, guide them to understand the the size (volume) is the same, but that the composition is different.

3. Have several students lift a test tube containing 5ml of mercury, and a 1,000ml flask of water.Ask, "Which flask is heavier?" "Why?" (Larger volume, heavier weight.)

4. Have some students lift the box containing the marbles and the one containing the ping-pong balls. Ask, "Which is heavier?" Open and display the contents of the boxes. (The students should understand that the heavier box contained many smaller, heavier objects than the **light** one.)

5. Define or elicit that density depends upon the amount of particles packed into a certain space. Tell the pupils that they will now do an experiment to find the density of an object. Distribute Pupil Work Sheets and help the pupils read the instructions.

SUMMARY:

Summarize by eliciting the following:

1. Density is the way we have of comparing the weight of different objects of unit size.
2. We find the density by dividing the weight by the volume.
3. A block of iron and a block of wood of equal size will have different weights because of the greater density of the iron.

HOMEWORK:

Find the densities of the things listed on the pupil worksheet.

TEACHER REFERENCES:

1. Elements of Physics, Baker, Brownlee & Fuller, Allyn & Bacon, Rockleigh, N.J.

2. Investigating Science 8, Kahn, Greenleaf, Groffman, Kauderer, L.W. Singer Co., Syracuse, N.Y.

PUPIL WORKSHEET
(May be duplicated for pupil use.)

Lesson 20. How can we figure out a new method of comparing weight?

MATERIALS:

spring balance
centimeter ruler
cubes of the following materials all of similar volume: sugar, clay, wood, metal

4 - 6" lengths of string

1. Using the ruler measure the length, height and depth of each item on your tray.
2. Figure out the volume by multiplying the length by the height by the depth. Example: Length 2 centimeters, height 2 centimeters, depth 2 centimeters. 2cm. x 2cm. x 2cm. = 8 cm.
3. Write the volume for each volume on the chart below.
4. Tie a string around each item and weigh it on the spring balance.
5. Write the weight of each item on the chart below.
6. Figure out the density of each item by dividing the weight by the volume. Example: Volume 4 cubic centimeters, weight 8 grams.

$$\frac{8 \text{ grams}}{4 \text{ cubic centimeters}} = \text{density of 2 grams per cubic centimeters}$$

Item	Volume (cubic centimeters)	Weight (grams)	Density (grams per cubic centimeter)

For homework figure out the densities of the following objects.

	length	height	depth	weight
a. Gold	2cm.	2cm.	2cm.	152 grams
b. Steel	1cm.	2cm.	2cm.	32 grams
c. Water	2cm.	3cm.	2cm.	12 grams
d. Stone	2cm.	1cm.	1cm.	6 grams
e. Cork	1cm.	2cm.	3cm.	2 grams

C. DENSITY

LESSON 21. What happens to water when you drop something into it?

OUTCOMES:

1. Displacement means to push aside or take the place of.
2. When a solid object is placed into water, the water level rises.
3. By measuring the rise of the water level we can determine the volume of the object placed into it.

MATERIALS:

Teacher

aluminum density block
rocks of irregular shape
250 ml graduated cylinder
centimeter ruler
spring balance

Pupil

10 ml graduated cylinder
3 - 4 irregular shaped objects (stones, lumps of metal, etc.)
Marbles may be used because their volume cannot be determined accurately with a ruler.
100 ml beaker

PROCEDURE:

1. Ask two pupils to come to the front of the room. Place a 3x5 sheet of paper on the floor. Have pupil A stand on the paper. Ask pupil B to stand on the paper without stepping on pupil A's toes.
   NOTE: Guide the pupils to realize that in order for one object to occupy the same space as another object it must push the first object aside. Write the term "Displacement" on the blackboard. Encourage pupils to define the term in their own words.

2. Review the steps to find the volume (l x h x d) and have a number of pupils find the volume of an aluminum density block. Ask others to weigh it for you. Put this information on the blackboard. Ask the class to find the density -
   $$\frac{\text{weight of object}}{\text{volume}} = \text{density}$$

3. Collect the rulers and challenge the pupils to repeat the experiment without the rulers.

4. Place 100 ml of water in a 250 ml graduated cylinder. Carefully place the aluminum density block into it. Have the pupils note what happens to the water level (displacement). Ask, "Why did the water level rise?"

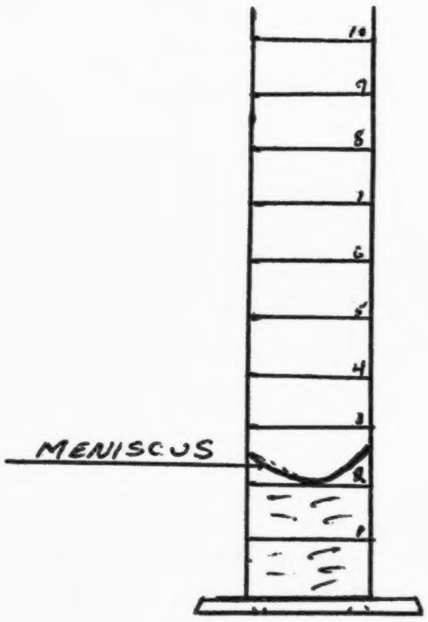
5. Calculate the density using the volume you found by the displacement method.
   NOTE: The amount the water level rose is equal to the volume of the object placed into it.

6. Explain that the volume of objects without flat sides (irregular shaped objects) can be determined in this manner.

7. Distribute pupil worksheets and read the instructions with the pupils.

NOTE:

The lowest point on the meniscus gives you the reading (see diagram). The meniscus assumes this shape due to the adhesion of water to the sides of the cylinder.



READING IS 2 ml. NOT 2.5 ml

SUMMARY:

1. Review the meaning of the new terms introduced in this lesson.
2. Ask pupils to explain how they can find the volume and density of various shaped objects. Urge them to use the examples found in their experiment.

HOMEWORK:

Answer the questions on the pupil worksheet.

TEACHER REFERENCES:

1. Science Experiences with Ten-Cent Store Equipment,
   Lynde, C.J., D.Van Nostrand,N.J.

2. Matter, Earth and Sky, Gamon, G.,
   Prentice - Hall Inc. Englewood Cliffs, N.J.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 21. How do we find the density of objects which do not have flat or straight sides?

MATERIALS:

10 ml graduated cylinder
3 -4 irregular shaped objects (stones, pieces of metal, etc.)
    Marbles may be used because their volume cannot be determined accurately with a ruler.
100 ml beaker half full of water

Pour some water into your graduated cylinder. Look at the top level of the water. Draw what the level looks like.

____

This curved level is called a Meniscus. To read this level, keep your eye level with the bottom of the curve.

____

PROCEDURE:

1. Fill your graduated cylinder so that the meniscus is on the 5 ml line.

2. Drop in one of the objects from your tray. What happens to the water level? ______________________________.

3. Write down the amount the water rose. ________________.

   (Example: Old level 5 ml, new level 8 ml, water rose 3 ml).

4. Drop the remaining objects into the cylinder one at a time and write down the amount the water rose in each case.

   a) ________________
   b) ________________
   c) ________________

5. The amount of rise is equal to the volume of the object.

HOMEWORK:

1. What is the water level called?

   ____

2. Why does the water level rise?

   ____

3. Look at number five above.
   a) If the water rose 5 ml what is the volume of the object? ________
   b) If the water rose 2 ml what is the volume of the object? ________

   Bonus question:

   If the water level rose 4 ml and the weight of the object is 8 grams, what is the density of the object? ______________________

C. DENSITY

LESSON 22. Why does a rock sink while a cork will float?

OUTCOMES:

1. Every element or compound has its own special density.
2. If an object's density is less than the density of another object, it will float on it (liquid on liquid, solid on liquid), or float higher in water if we are comparing two solids.
3. If an object's density is more than the density of another object it will sink into it.

MATERIALS:

Teacher

two 250 ml beakers
iron nail
25 ml mercury
density table (teacher prepared)

Pupil

50 ml graduated cylinder
10 ml of each: alcohol, water linseed oil and mercury
pea-size piece of each: pine wood, beeswax or paraffin, coal,
beryllium or magnesium
small iron nail

PROCEDURE:

1. Drop an iron nail into a beaker of water.

2. Arouse pupil curiosity by challenging pupils to float a nail without placing it on a piece of wood.

3. Pour some mercury into a beaker and float the nail on it. Elicit pupil suggestions as to why the nail floats on mercury but not on water.

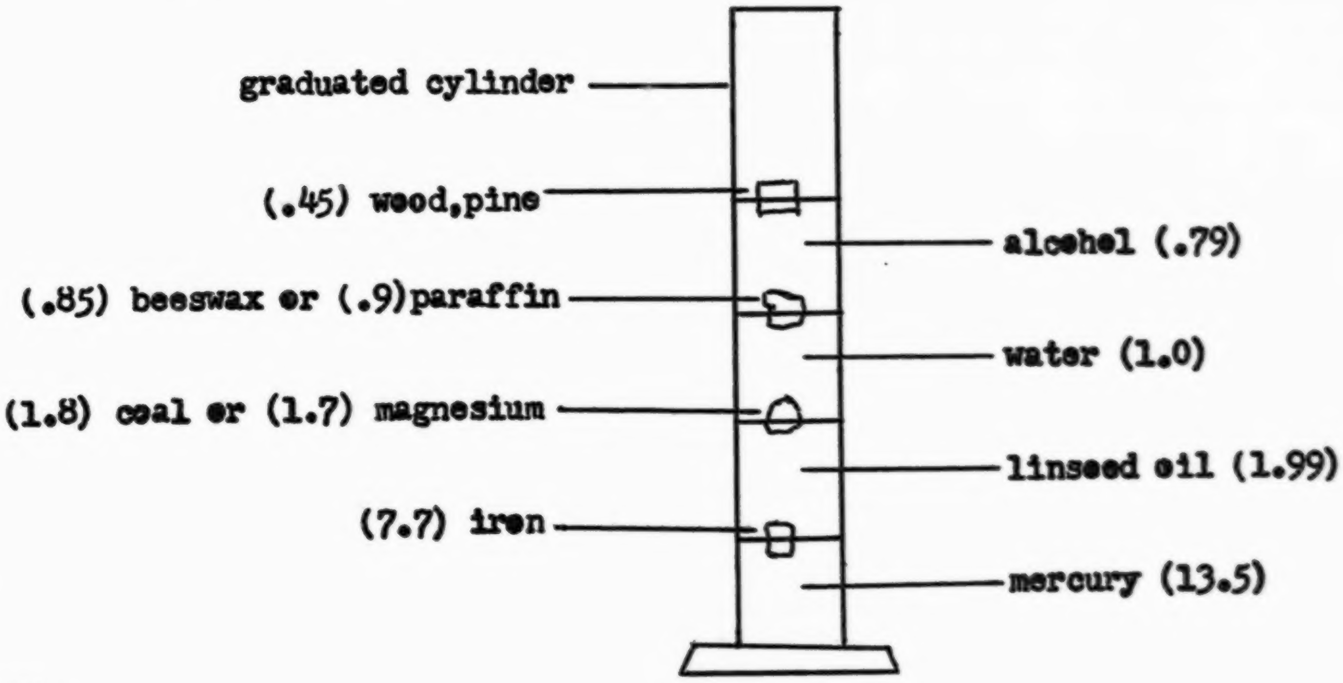
   Note: The density table referred to below in #4 will be found on the pupil worksheet. It will be used by pupils to guide them in preparing the density column shown in item #5. It contains more substances than are required for the lesson. You may use any combination you wish according to what is available in the school. REMEMBER that the substance having the lower density will float on the liquid having the greater density. For additional densities refer to the bibliography or to the "Handbook of Chemistry and Physics".

4. Referring to the density table on the pupil worksheet, ask, "How can knowing the densities of water, iron, and mercury give you a clue toward explaining why the nail floats on mercury and sinks into water?"

5. Distribute pupil worksheet.

   Note: Some of the liquids used in the pupil's experiment may mix together if it is poured quickly. The cylinder should be tilted and the liquids poured down the sides very slowly and carefully. Have the pupils avoid sudden movements with the cylinder. It should look like this.

Suggested density column


graduated cylinder
(.45) wood,pine
alcohol (.79)
(.85) beeswax or (.9)paraffin
water (1.0)
(1.8) coal or (1.7) magnesium
linseed oil (1.99)
(7.7) iron
mercury (13.5)

SUMMARY:

Summarize by asking the following questions:

1. If you had to tell the difference between two substances which looked alike, smelled alike, and tasted the same, how would today's experiment help you tell the difference?
2. When does a nail float? Why?
3. When does a nail sink? Why?
4. What does density mean and how do we find it?
5. If an object gets bigger, does the density of that object get greater too? Why?

HOMEWORK:

Complete questions on pupil worksheet not completed in class.

REFERENCES:

1. Elements of Physics, Baker, Brownlee and Fuller, Allyn and Bacon, New York, N.Y.

2. Basic Physics, Efron, Alexander, John F. Rider Inc., New York, N.Y.

3. Graphic Survey of Chemistry, Lemkin & William, Oxford Book Co., New York, N.Y.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 22. How do we build a density dolumn?

MATERIALS:

50 ml graduated cylinder
small piece of wood (pine)
10 ml alcohol
10 ml water
10 ml linseed oil
10 ml mercury
small piece of beeswax or paraffin
small piece of coal, berylium or magnesium
small iron nail
table of densities

Table of Densities

Solids		Liquids	
cork	0.22-0.26	alcohol	0.79
iron	7.0 -7.9	mercury	13.5
wood, pine	0.45	linseed oil	1.99
coal	1.2 -1.8	water	1.0
beeswax	0.85	kerosene	0.8
paraffin	0.8 -0.9	olive oil	0.9
berylium	1.82	glycerin	1.26
magnesium	1.7		

PROCEDURE:

Have you ever seen an oil fire burning on top of water in a movie or TV program. Why does the oil continue to burn? Doesn't the water put out the fire? The experiment outlined below may give you some ideas to help you answer the questions.

1. Look at the table of densities. Which substance has the greatest density? ____________________. The least density?____________.

2. Lift each of the substances. Which is the heaviest?____________ The lightest?________________

3. Pour the mercury into the graduated cylinder.

4. Tilt the cylinder and slowly add the liquid which is closest to mercury in density. (See your chart). Check with your teacher to see if you are right.

5. Pour in very carefully the next liquid, then the last one. Each liquid should now be floating on the other. What would happen if the last liquid was placed in first?_________________________

6. Take the solid object with the density of 1.8. Before you drop it in answer the following:
   a) Name the layers it will sink through ____________________
   b) Name the layer it will float on ________________________

7. Now drop the object into the cylinder. Did you predict (guess) correctly?

8. Drop in the objects one at a time. The iron nail will sink through the first three layers but will float on the mercury. Why?

   ____

Questions to be answered:

1. If an object has a greater density it will have a __________ weight.
2. Prepare a list for each object you used as follows:

object	object density	liquid it floats on	liquid density

C. DENSITY

LESSON 23. How can we get metal to float on water?

OUTCOMES:

1. The greater the volume of an object, the greater the amount of water it displaces.
2. When the amount of water displaced weighs as much as the object placed into it, the object will float.
3. Metal will float if we can increase its volume so that the weight of the water it displaces will equal the weight of the metal.

MATERIALS:

Teacher

iron nail
2 vegetable cans of the same size
2 - 500 ml beakers
tin snips
overflow can
catch bucket
balance
wood and metal block of equal volume

Pupil

2 three inch squares of copper foil
250 ml beaker

PROCEDURE:

1. Drop an iron nail into water.

2. Referring to the previous lesson, ask, "Why did the nail sink?"

3. Ask pupils to guess what a ship might weigh. Since the density of the steel in a ship is greater than water, and the ship weighs thousands of tons, there must be another reason for a ship to float.

4. Display two vegetable cans of the same size. Cut one can open with tin snips. Fold the cut can and drop it into a beaker of water. Call attention to the rise in water level. Take the other can and place it into another beaker of water. Press down, and point out the rise in water level. Ask, "In which case did the water rise the highest?" "Why did the water rise higher in the beaker containing the complete can?" Elicit the fact that since the complete can and the air it contained had a greater volume than the folded can,it displaced a larger amount of water.

5. Point out the complete can floating in the beaker and ask, "What clue do you have as to why the first can sank and the second can floats?" Elicit that floating seems to be related to the amount of water displaced.

6. Copy the chart below onto the blackboard. Call upon a pupil to write the results on the blackboard. Invite others to perform the following experiment. Weigh the wood block and the metal block in air. Drop the metal block into the overflow can and catch and weigh the displaced water. Refill the overflow can, press the block just below the surface. Collect and weigh the water displaced.

A	B	C	D	E	F
Type of object	Weight of object in air	Weight of water displaced plus weight of catch bucket	Weight of catch bucket	Weight of displaced water	Sinks or floats
METAL					
WOOD					

7. Refer to the completed chart and ask, "Why does wood float?'

Note: Tell the pupils to pay particular attention to column B and E. Guide them to understand that the weight of the water displaced by the wood equals (or may be greater than) the weight of the wood in air. Also the weight of the water displaced by the metal is less than the weight of the metal in air.

SUMMARY:

Summarize by asking the following:

1. When an engineer or architect is ready to design a ship, and he figures out the weight of the ship, he must next figure out the ____________ and the ____________.
2. Why must an engineer worry about how many men and how much equipment will be put into a ship?

TEACHER REFERENCES:

1. Matter, Earth, and Sky, Gamou, George
   Prentice - Hall Inc., Englewood Cliffs, N.J.

2. Modern Physical Science, Brooks, Tracy, Tropp and Friedl,
   Holt, Rinehart and Winston Inc., New York.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 23. How can we get metal to float on water?

MATERIALS:

2 three-inch squares of copper foil
250 ml beaker

PROCEDURE:

1. Measure the two squares of copper. Are they equal in size? ________
2. Fold up one square and place it carefully into a beaker of water. What happens? ____
____
3. Fold up the sides of the other square and place it carefully into the beaker of water. What happens? ______________________________
____
4. Remove both pieces of copper and place them side by side. Does the first or second piece of copper take up more space? ______________
5. Why did the second square float? ______________________________
____
6. Explain in your own words when an object will sink or float.________
____
____

C. DENSITY

LESSON 24. Is density used only for floating boats?

OUTCOMES:

1. Nearly all substances have a different density.
2. By knowing the density of a substance we can identify it.
3. A hydrometer is an instrument which enables us to quickly test the density of liquids.

MATERIALS:

Teacher

two 100 ml beakers
hydrometer

Pupil

1 plastic straw per pupil
modeling clay
100 ml each of water, glycerine, and alcohol
100 ml graduated cylinder
soft lead pencil
2 tall jars; one containing water, the other a concentrated salt solution
$\frac{1}{2}$ inch brads

PROCEDURE:

1. Display two beakers containing colorless liquids.

2. State that one contains water and the other a liquid which, if tasted,or inhaled, will produce illness. (The second beaker contains only a concentrated salt solution to avoid accidents.)

3. Encourage the pupils to make suggestions as to how they can determine the contents of the beakers without tasting or smelling the liquids.

   Note: Most suggestions will usually require complicated or expensive equipment and techniques. Suggest that the pupils might like to build a simple instrument which will solve the problem.

4. Distribute pupil worksheets.

   Note: Prior to the lab experiment, fill one jar with water and label it "A". Fill another with concentrated salt solution and label it "B".

5. After the pupil activity has been completed show a commercial hydrometer.

6. Discuss the uses to which a knowledge of density can be applied (testing automobile batteries, separating oils, testing milk for butter fat, and testing wine, beer, and whiskey for alcohol content).

SUMMARY:

Refer the pupils to the density table of lesson #22. Tell them to look at the column headed "liquids", and ask the following:

1. "What do you notice about the densities of the different liquids?"
2. "How can a hydrometer be used in telling the difference between the two liquids on my desk?"

HOMEWORK:

Complete homework on pupil worksheet.

REFERENCES:

1. Sootin, Harry. Experiments With Machines and Matter. New York: W.W. Norton and Company.

2. Linde, C.J. Science Experiences With Ten-cent Store Equipment. New Jersey: D. Van Nostrand.

3. Baker, Brownlee and Fuller. Elements of Physics. Rockleigh,N.J.: Allyn and Bacon.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

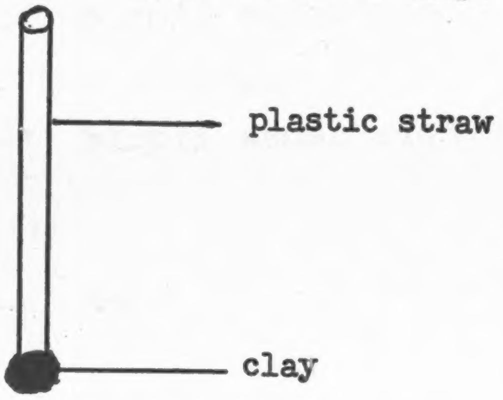
LESSON 24. How do we build an instrument which will test the density of liquids?

MATERIALS:

1 plastic straw
modeling clay
100 ml graduated cylinder
100 ml each of water, glycerine, and alcohol
soft lead pencil
one jar of water, one jar of sea water
several ½ inch brads

PROCEDURE:

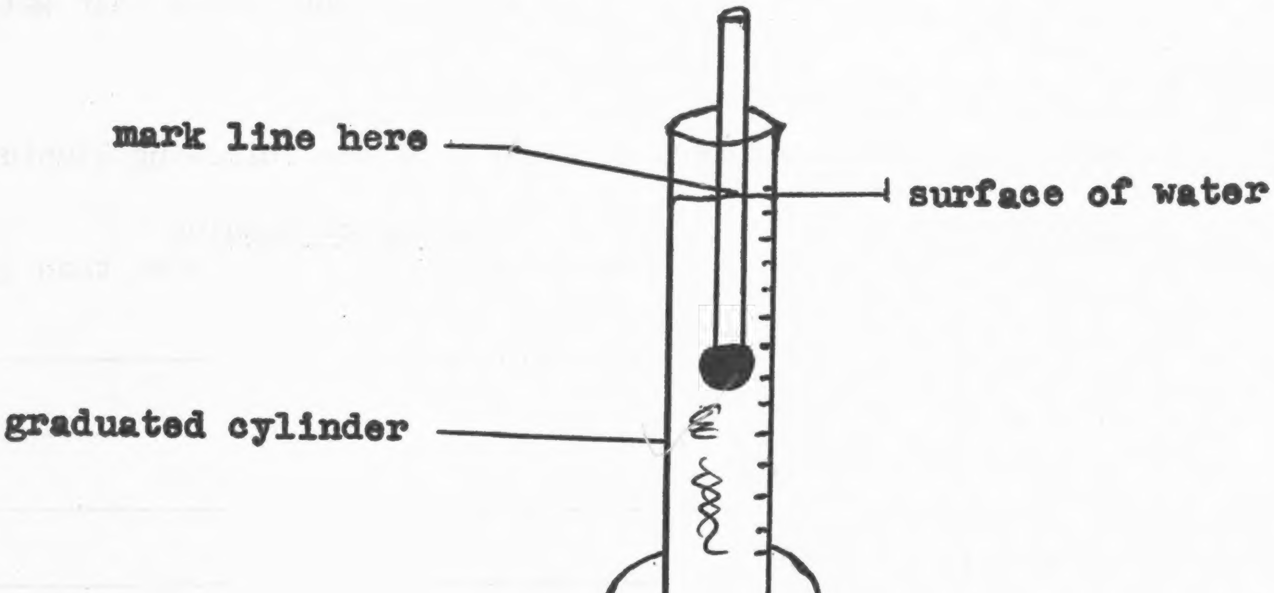
1. Close the end of a straw with a small piece of clay.



2. Fill a 100 ml graduated cylinder with water.

3. Place the straw into the cylinder and slide the brads down the straw one at a time until the straw floats without tipping over.

4. Mark a line on the straw with a pencil at the point where the straw touches the surface of the water. Mark this line 1.0.



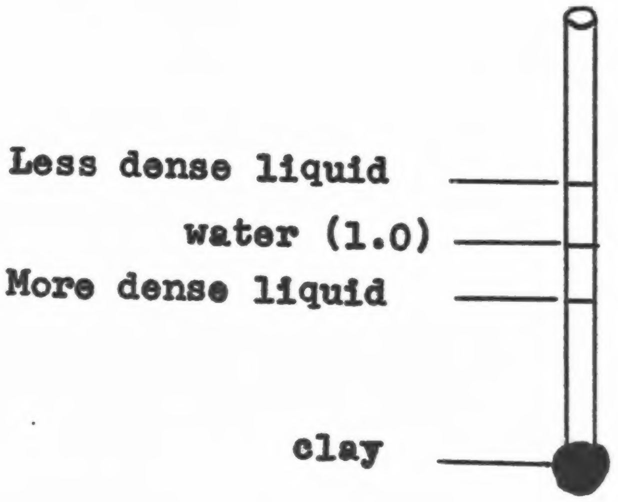
5. Pour out the water and fill the graduated cylinder with alcohol. Place your straw into the alcohol. Does it float higher or lower than in water? ______________________________.

6. Mark a line as before and label it .79.

7. Pour out the alcohol and fill it with the glycerine. Place your straw into the glycerine. Does it float higher or lower than in water? ______________________________

8. Mark a line as before and label it 1.26.

9. When finished the straw should look like the diagram below.



10. If a liquid is more dense than water the straw will float __________.
If a liquid is less dense than water the straw will float __________.

11. The instrument you have made is used to test the density of liquids. We call this instrument a HYDROMETER.

12. Test the liquids in jars A and B. Which one contains the sea water?

____________________ Hint: Sea water is more dense than water.

HOMEWORK:

1. With your hydrometer test at least 6 of the following liquids at home.

Liquid	Hydrometer Reading	
	less than 1.0	more than 1.0
milk	__________	__________
skim milk	__________	__________
honey	__________	__________
olive oil	__________	__________

peanut oil ____________ ____________

cotton seed oil ____________ ____________

corn oil ____________ ____________

maple syrup ____________ ____________

corn syrup ____________ ____________

molasses ____________ ____________

coffee ____________ ____________

tea ____________ ____________

shampoo ____________ ____________

vinegar ____________ ____________

salt water ____________ ____________

Make sure you rinse the hydrometer after each test.

2. In your own words tell how a hydrometer helps you find out what a liquid is made of.

D. PRESSURE

LESSON 25. Why does a knife cut?

OUTCOMES:

1. Pressure equals force per unit area.
2. Pressure can be increased by increasing the force or decreasing the area.
3. Pressure can be decreased by decreasing the force or increasing the area.

MATERIALS:

Teacher

square of clay
kitchen knife

Pupil

square of clay (1½ square inches)
2 thumb tacks
100 ml beaker
rubber band
small sheet of thin paper
500 gram weight
thin thread

PROCEDURE:

1. Attempt to cut through a piece of clay with the flat side of a knife. Ask, "Why doesn't the knife cut?" Establish that the wrong part of the knife blade is being used.

2. Ask, "How can we cut through the clay?" After receiving the correct answer, cut through the clay.

3. Ask, "What is the difference between the flat side and the sharpened edge?" Through this line of questioning establish the fact that area is involved in the cutting process.

4. Place the knife on the clay. Ask, "Why doesn't the knife cut through the clay?" The pupils should come to the conclusion that a force is also needed.

5. Refer back to the previous steps and ask,"What happened to the clay when we used a force and a large area? What happened when we used a force and a small area?'

6. State that when we apply a force over an area we produce pressure.

7. Write the formula: "pressure equals the force divided by the area" on the board. Substitute the symbols $P = \frac{F}{A}$

8. Refer back to the fact that when we used a large area of the knife we could not cut the clay. We were, however, successful using a small area.

9. Guide the pupils to solve several simple problems.

10. Distribute pupil worksheets.

SUMMARY:

Summarize by eliciting the following.

A knife cuts because of the extremely small area of the sharpened edge. This creates a tremendous pressure when a force is applied to it.

HOMEWORK:

Find the pressure in the following examples.

	FORCE	AREA
1.	10 pounds	2 square inches
2.	20 pounds	4 square inches
3.	10 pounds	5 square inches
4.	100 pounds	5 square inches
5.	100 pounds	2 square inches

REFERENCES:

1. Kahn, Greenleaf, Groffman and Kanderer. Investigating Science 8. Syracuse, New York: L. W. Singer

2. Baker, Brownlee and Fuller. Elements of Physics. Rockleigh, New Jersey: Allyn and Bacon.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

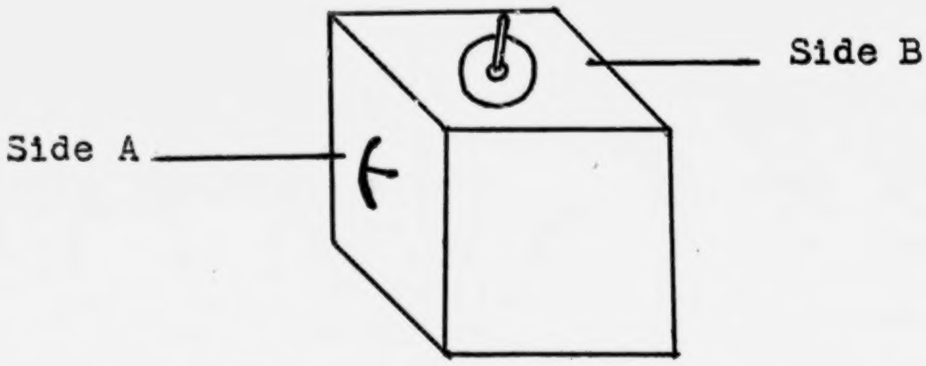
LESSON 25. What effect does area have on pressure?

MATERIALS:

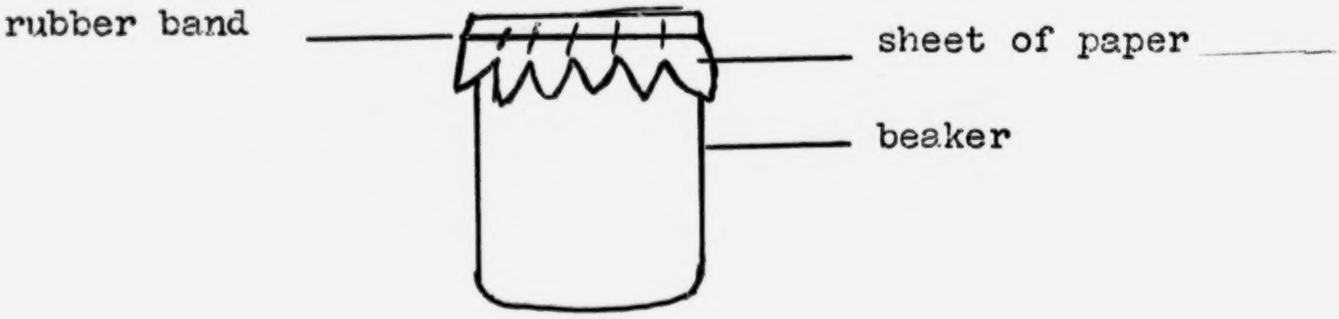
square of clay ($1\frac{1}{2}$ square inches)
2 thumb tacks
100 ml beaker
rubber band
small sheet of thin paper
500 gram weight
thin thread

PRODECURE:

1. Stick one thumb tack into one side of the clay. This is side A. Press the head of the second thumb tack into another side of the clay, so that the point sticks out. Label this side B. (See diagram.)



2. Stretch a sheet of paper over a beaker. Hold the paper in place with a rubber band.



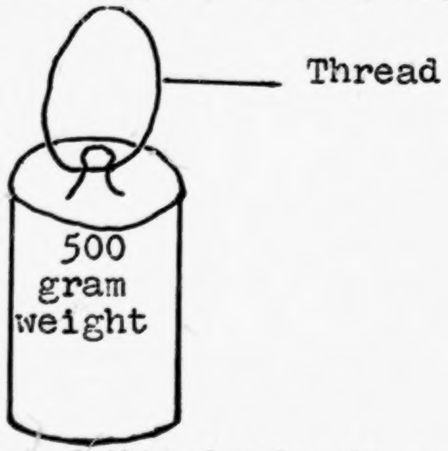
3. Hold the clay over the beaker so that side A is above the paper. Drop the clay. Does the thumb tack go through the paper? ________.

4. Holding side B above the paper, drop the clay. What happens?

____.

5. Lift the weight between your first two fingers. Put it down.

6. Tie a piece of thread to the weight so that a loop is formed.



7. Lift the weight by the loop of thread using the same two fingers. In which case did the pressure feel greater?____________________.

Questions to be answered:

1. Why did the point of the thumb tack go through the paper, while the head did not?

____

____.

2. Why was the pressure greater when you used the thread to lift the weight?

____

____.

D. PRESSURE

LESSON 26. Are you stronger than air?

OUTCOMES:

1. We are surrounded by an ocean of air.
2. Air exerts a very powerful force.
3. Air pressure depends upon the number of "collisions" between molecules of air and a surface. The more molecules in a given area, the greater the pressure.

MATERIALS:

Teacher

empty gallon can with cap
tripod
bunsen burner
Magdenburg Hemispheres
vacuum pump
Teacher-made atmospheric model
See item 5 below.

Pupil

bottle
one-hole rubber stopper with glass straw inserted

PROCEDURE:

Note: At the start of the period begin heating a small amount of water in the gallon can.

1. Ask the pupils to move their hands about. Ask one pupil to describe what he is pushing against.

2. Challenge the pupils by stating, "Even though you can easily push your way through the air, I say the air is stronger than you are."

3. Call their attention to the can which by now should have steam coming out. Explain that the steam is displacing the air inside the can. Turn off the heat and cap the can. As the can cools and the steam contracts, the greater outside pressure will collapse the can. Ask, "Why did the can collapse?"

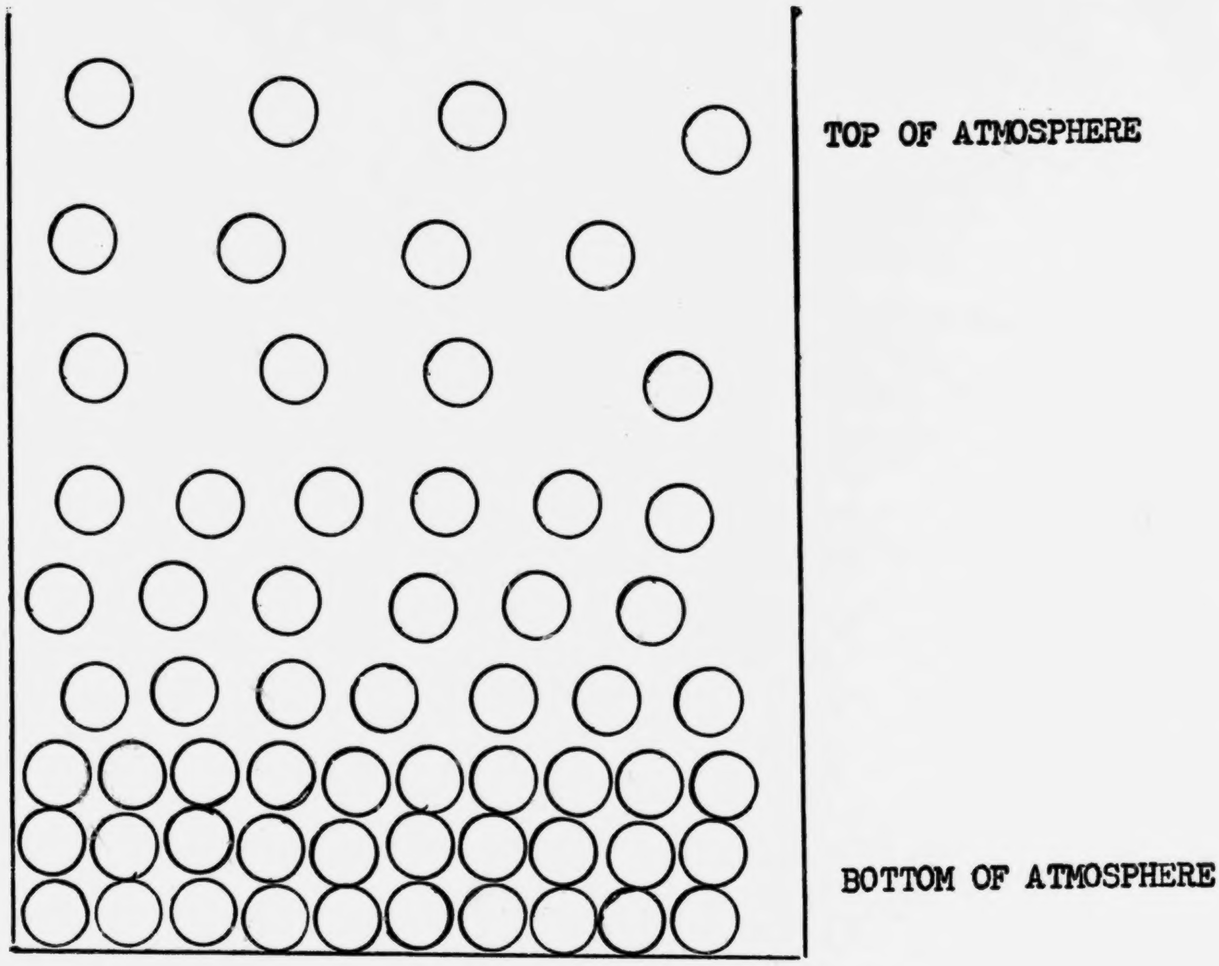
4. Hold the Magdenburg Hemispheres together and call upon a pupil to evacuate the air. Explain that air is holding the hemispheres together. Call for two large volunteers who think they are stronger than air, to pull the hemispheres apart.

When they fail, open the stopcock and call the pupils' attention to the sound of the incoming air. Call upon the smallest pupil and have him separate the hemispheres.

Optional: If a vacuum pump and plate apparatus (S - 1, 14 - 0818) is available perform the following demonstration. Place the evacuated Magdenburg Hemispheres on the plate, cover with a bell jar and evacuate the air surrounding the hemispheres. After several minutes tap the plate. The hemispheres will fall apart.

5. Display the atmospheric model.

Note: The following may be made from cardboard and clay or marbles.



6. Place your hand at any level. Elicit from the pupils that the amount of clay "molecules" are equal on top and bottom of the hand.
7. Place your hand near the top of the display and ask, "Would the pressure be greater or less here?" "Why?" (Less collisions, Less pressure.)
8. If time permits drop a few glass beads into a round-bottom flask to demonstrate low pressure conditions. Drop many in to demonstrate high pressure.
9. Distribute pupil worksheet. Guide the pupils in following the steps of the pupil worksheet.

SUMMARY:

Review the idea that air exerts a pressure because of the number of molecules colliding at a given level. Elicit uses for the force exerted by air (lifts, tires, airplane flights).

HOMEWORK:

What do you think?

1. If air is so powerful why doesn't it crush in our chests?
2. Why isn't a car crushed flat?

Bonus question:

How is it that you are able to lift your hand, if the whole atmosphere is on top of it?

REFERENCES:

1. Efron, A. Basic Physics. New York, N.Y., John F. Rider
2. Dull, Metcalfe, Williams, Modern Physics. New York, N.Y. Holt, Rhinehart and Winston.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 26. How does air pressure help us to drink through a straw?

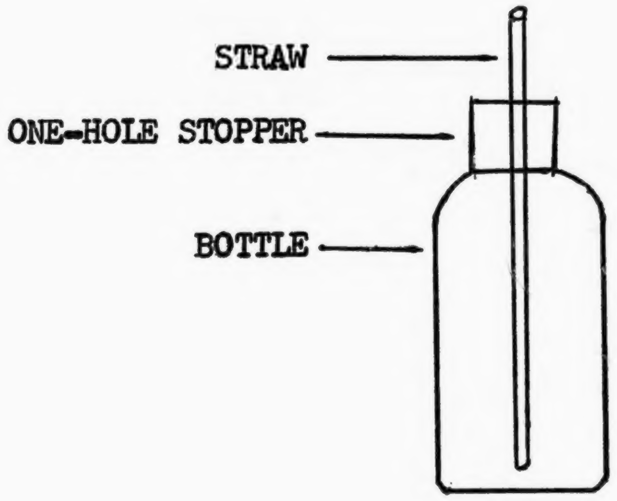
MATERIALS:

any size bottle available
one-hole rubber stopper with straw inserted

PROCEDURE:

1. Fill the bottle full of water.

2. Put in the stopper containing the straw. Make sure the stopper is tight.



3. Drink through the straw. What happens? ______________________________

4. Loosen the stopper and drink through the straw. What happens? ______

____

5. Why were you able to drink the water in step # 4 and not in step # 3?

____

____

D. PRESSURE

LESSON 27. How does a pitcher throw a curve ball?

OUTCOMES:

1. As air moves, its pressure becomes less.
2. If the pressure on one side of an object is less then on another side, the object will be pushed by the greater air pressure.

MATERIALS:

Teacher

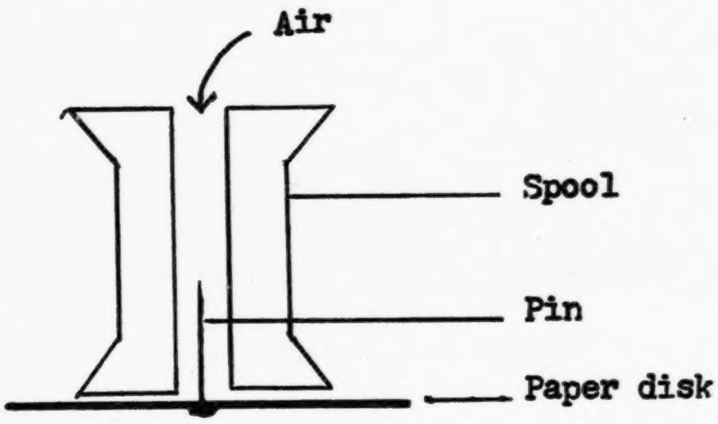
thread spool
straight pin
four inch paper circle
ball with six foot string attached

Pupil

3x5 yellow paper
two ping-pong balls with six inch strings attached

PROCEDURE:

1. Find the center of a four inch circle of paper. Push a straight pin through the center and place the pin in the center of a thread spool. (See diagram.)



2. Hold the paper to the bottom of the spool and ask, "What would happen if I let go of the paper?" Demonstrate.

3. Ask, "What would happen if I blew through the top of the spool?"

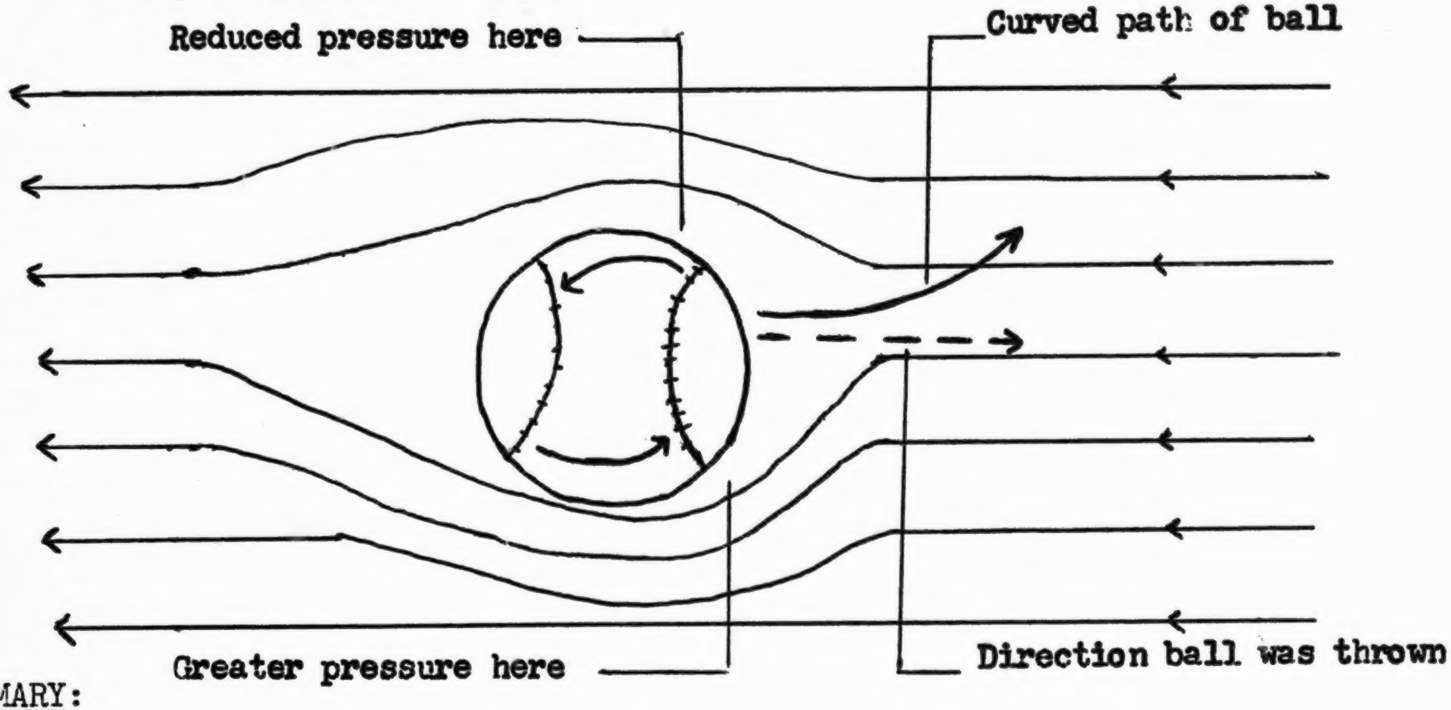
4. Blow vigorously through the top of the spool. (The paper will stick to the spool due to the lowered pressure between the paper and the spool.) DO NOT explain the results at this time.

5. Distribute pupil worksheets. Read the questions in the procedure to the pupils and elicit answers before allowing them to perform.

6. Ask the following series of questions:

   a. What pushed the ping-pong balls together? (Air)
   b. What was the difference between the air on the outside of the ping-pong balls and the air on the inside? (The air between the ping-pong balls was moving.)
   c. Where was the air pressure greater? (On the outside.)
   d. How do you know? (The balls moved together.)
   e. What happens to the pressure of air when the air moves?

7. Suspend a ball from the ceiling or light. Place a ruler on the desk. Pull the ball back in a straight line and release. Point out to the pupils that the ball swinging in an arc, stays in the same plane. Twist the ball and string and repeat the demonstration. Point out the curved path the ball now takes. Explain that a pitcher must spin the ball in order to curve it. This spinning motion creates a lower pressure condition on one side of the ball, causing it to curve.



SUMMARY:

1. Ask, "Why did the paper remain stuck to the spool?"
2. Review the concepts developed in this lesson relating to the difference in pressure around an object. Ask volunteers to explain the ideas in their own words.

HOMEWORK:

See pupil worksheet.

REFERENCE:

Dull, Metcalfe, Williams, Modern Physics, New York, N.Y.
Holt, Rhinehart and Winston.

Note: For the next lesson ask the pupils to bring in a medium-sized jar, such as a pickle jar, a mayonnaise jar or an applesauce jar.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 27. What happens to the pressure when air moves?

MATERIALS:

3x5 yellow paper
two ping-pong balls with six inch strings attached

PROCEDURE:

1. Place the piece of paper between your thumb and forefinger. What do you think will happen if you blow across the top of the paper?

   ____

2. Blow across the paper. What happened?

   ____

3. Hold up the ping-pong balls about three inches apart. In which direction will the ping-pong balls move if you blew between them?

   ____

4. Blow between the ping-pong balls. What happened?

   ____

5. What was happening to the air when you blew across the paper, and between the ping-pong balls?

   ____

HOMEWORK:

1. How do you explain the fact that the paper went up as you blew across it?

2. Why did the ping-pong balls move toward each other?

BONUS QUESTION:

How does a pitcher get a ball to curve?

D. PRESSURE

LESSON 28. How do we measure pressure?

OUTCOMES:

1. The normal air pressure at sea level can raise a column of mercury 30 inches.
2. Air pressure is usually measured by a mercury barometer or an aneroid barometer.

MATERIALS:

Teacher

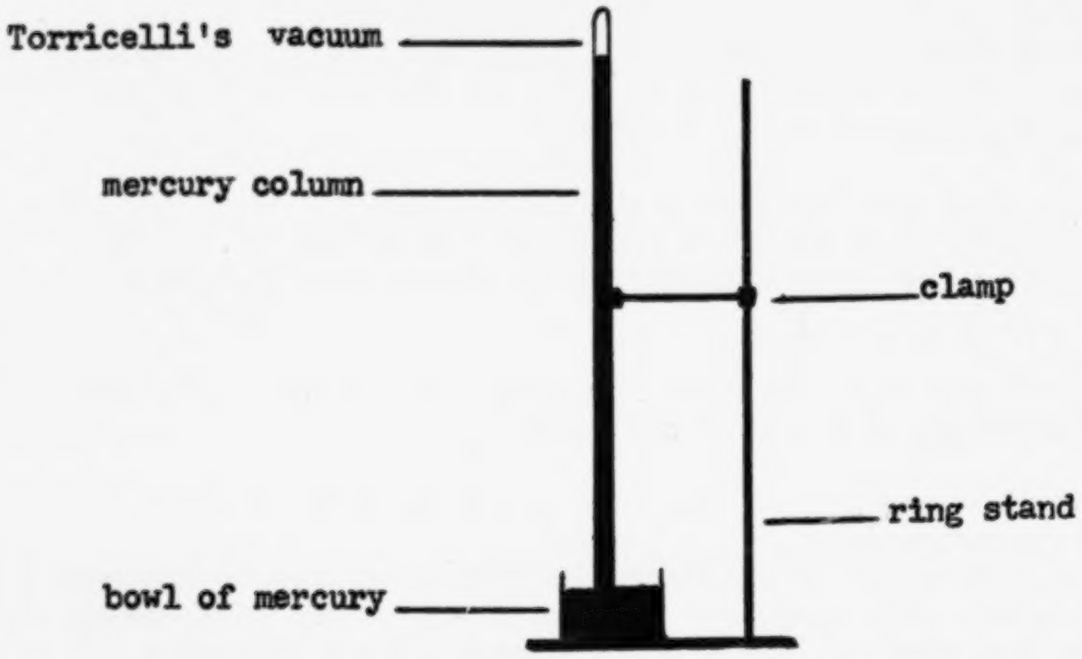
Torricelli barometer demonstration
36 inch glass tube filled with mercury
meter stick
aneroid barometer
Torricelli barometer in glass jar (see diagram)

Pupil

medium-size jar
thin rubber sheet 5x5 inches
rubber band
2 plastic straws
lump of clay
straight pin
six inch strip of paper
glue

PROCEDURE:

Note: Toricelli's barometer should be prepared as follows: Seal off the end of a 36 inch, heavy-walled glass tube or use a barometer tube if one is available at the school. Using a thin medicine dropper, fill the tube with mercury. (The medicine dropper is prepared by heating the center of one foot of glass tube and drawing it out.) Note: It may be necessary to tap the side of the barometer tube to get the mercury to fall. Place a finger over the open end of the tube and invert the tube into a dish of mercury. Clamp the tube to a ring stand as shown in diagram.

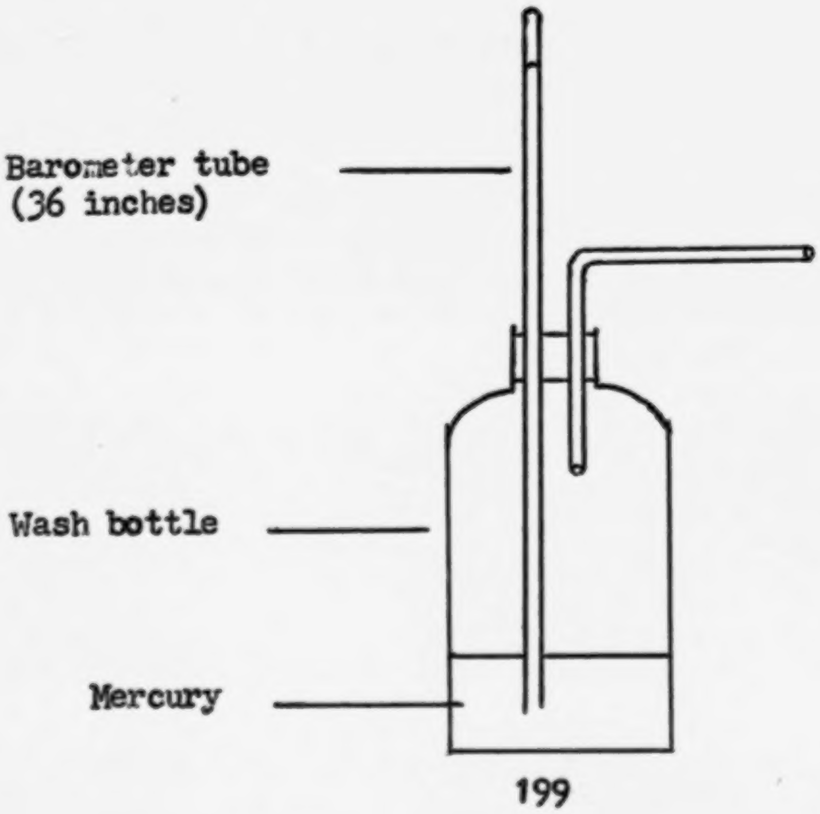

Torricelli's vacuum
mercury column
clamp
ring stand
bowl of mercury

1. Display a similar tube which has been filled with mercury. Allow the mercury to fall into a beaker. Ask, "Why doesn't the mercury fall out of the first tube?" (Establish the fact that air pressure is holding it up.)

2. Call upon a pupil to measure the height of the mercury column in the tube.

3. State that normally the column should read 30 inches. Ask, "How can we change the height of the column to read 29 inches?" "Thirty-one inches?"

4. To demonstrate the changes in air pressure, set up the following demonstration.


Barometer tube
(36 inches)
Wash bottle
Mercury

Have a pupil blow into the curved tube. Point out the effect on the mercury column. Ask the same pupil to draw out the air in the jar. Point out the change in the mercury column.

5. Discuss the fact that air pressure readings can help us determine the weather forecast. (Low pressure and a falling barometer indicate approaching storm. High pressure, rising barometer indicate fair weather.)
6. Ask, "Why wouldn't you use a mercury barometer as a weather forecaster on a boat?" (Too large, breakage, spillage)
7. Display an aneroid barometer and describe its operation. Explain why it can be made pocket-size.
   Note: The back cover or diaphragm is very sensitive to pressure changes. The diaphragm in turn is connected to a spring and a system of levers which move a pointer across a graduated scale.
8. Distribute pupil worksheets.

SUMMARY:

The question, "How does a pilot know how high he is flying?" will help summarize ideas involved in changing pressures.

HOMEWORK:

See pupil worksheet.

REFERENCES:

Baker, Brownlee and Fuller. Elements of Physics
Rockleigh, New Jersey: Allyn and Bacon

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

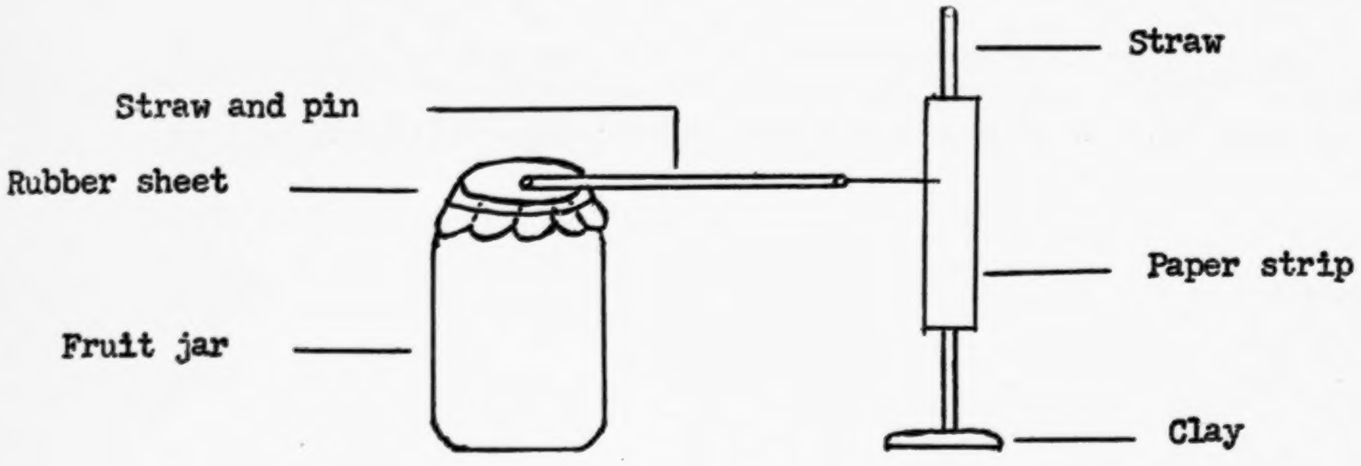
LESSON 28. How can we measure air pressure with a jar?

MATERIALS:

- medium size jar
- thin rubber sheet 5x5 inches
- rubber bands
- 2 plastic straws
- lump of clay
- straight pin
- six inch strip of paper
- glue

PROCEDURE:

1. Cover a jar with a rubber sheet. Pull it tight and fasten with a rubber band.
2. Place a lump of clay into one end of a plastic straw. Stick the head of a straight pin into the clay. Glue the other end of the straw on to the middle of the rubber sheet. This is your barometer.
3. Place another straw, which has the six inch strip of paper glued on it, into a lump of clay on your desk. This will be your scale. The set-up should look like the diagram.



4. Place your barometer near the scale and draw a line where the pointer comes to rest. Mark this line 30 inches. Why? ____

____

5. Would the air pressure be higher or lower if the pointer moved above this line? ____
Would the air pressure be higher or lower if the pointer moved below this line?____

HOMEWORK:

Fill in the following chart.

WEATHER WHEN BAROMETER WAS MADE ______________		
DAY OF WEEK	POINTER ABOVE OR BELOW LINE	TYPE OF WEATHER (fair,rain,cold,hot)

After one week turn in your results and your teacher will discuss them.

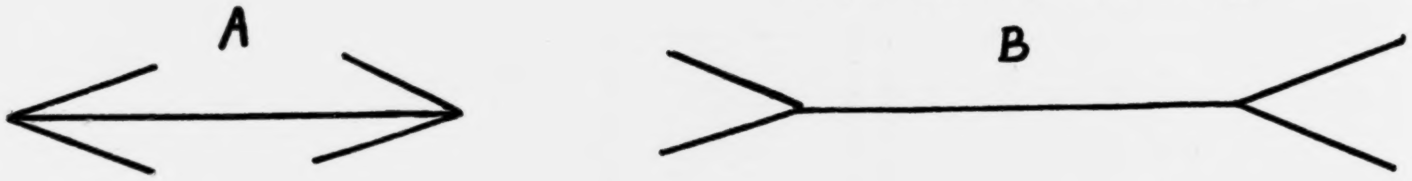
CAREER GUIDANCE - PHYSICS

SELECTED ENRICHMENT EXPERIENCES

MEASUREMENT - LENGTH

SCIENCE WORLD

VOL. 2 No. 1
September 16, 1965 - Page 10

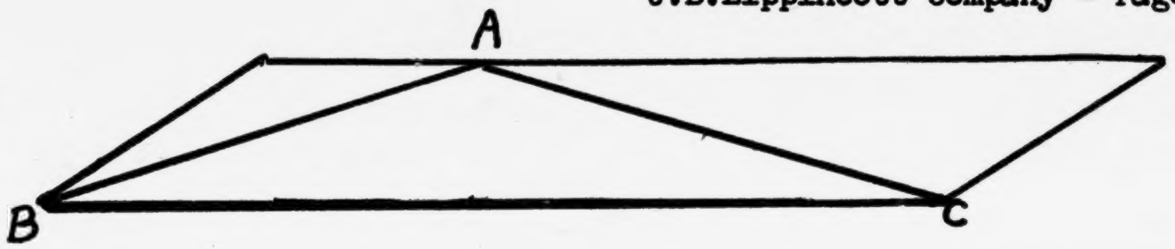


Prove which line is longer. Which line looks longer? Determine the actual length of each line using your own calibrated straight edge. Why did our eyes fool us? Stress the need to use fixed standards for accurate comparison.

MEASUREMENT - LENGTH

FUN WITH PENCIL AND PAPER

Joseph Leeming
J.B.Lippincott Company - Page 88

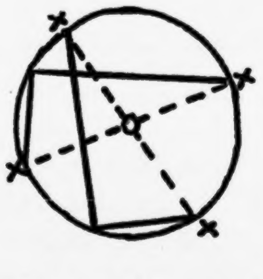


Is Line AB longer than line AC? You can prove that both lines are equal. Use your calibrated straight edge to prove this fact. Why do the lines appear to be unequal? Try to think of other ways to use your ruler to prove facts of accurate measurement.

MEASUREMENT - LENGTH

SCIENCE PUZZLERS

Martin Gardner
The Viking Press - Page 55

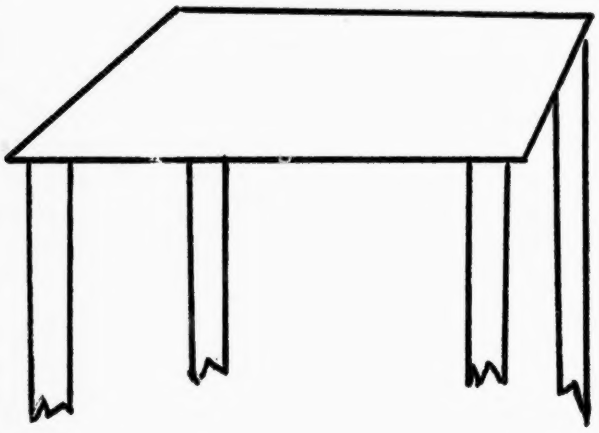


Can you find the exact center of a circle? You can use a rectangular sheet of paper to mark off the points on the edge of the circle. Do this twice and then draw a straight line between each pair of points. The point where the two lines meet is the center of the circle. Prove this by using your ruler to measure each half of the line. What do we call a line that divides a circle in half?

MEASUREMENT - AREA

SCIENCE PUZZLERS

Martin Gardner
The Viking Press - Page 34

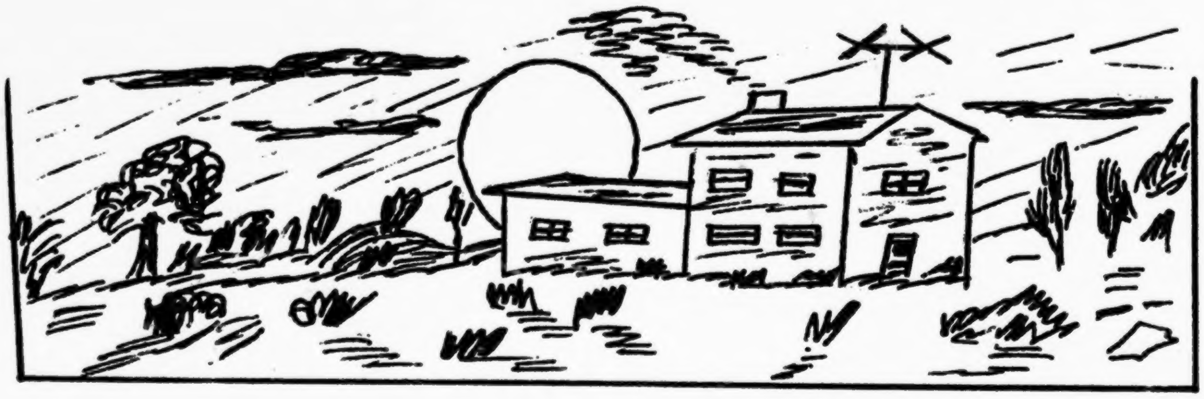


Can you put a penny on this table? At first, this seems very easy. But when you try it, you will find it is not possible. The area of the penny has dimensions greater than the actual dimensions of the table as drawn. The area of the table only seems larger because of the illusion of space caused by oblique perspective.

MEASUREMENT - AREA

SCIENCE PUZZLERS

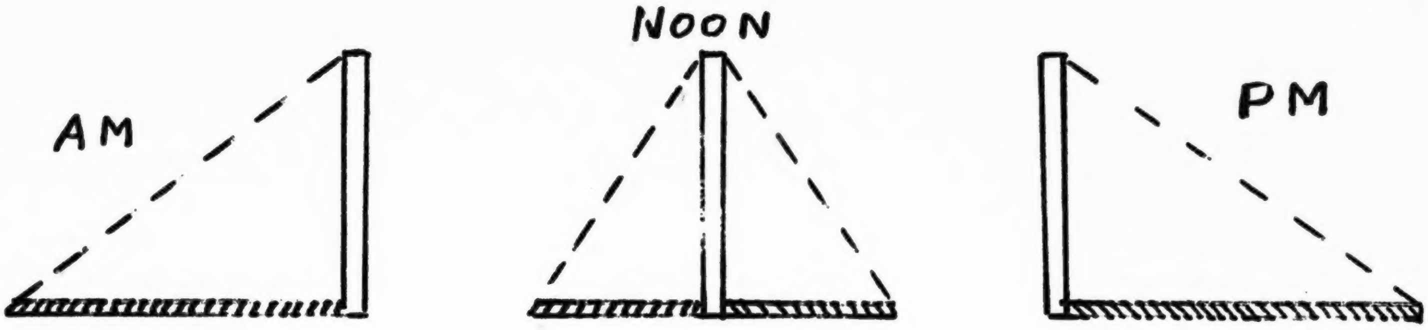
Martin Gardner
The Viking Press - Page 33



Why does the moon appear smaller when viewed almost overhead as compared to its size when viewed along the horizon? You can measure the area of the moon when viewed from each position. Mount a paper clip on the end of a yard stick. Use the paper clip as an "ironsight" when observing the moon from the other end of the stick. The observed moon size will cover as much of the paper clip no matter what position the moon has in relation to the earth.

MEASUREMENT - LINEAR

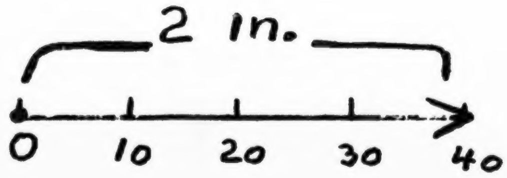
SCIENCE GRADES K-6 #2
BOARD OF EDUCATION, N.Y.C. Earth in Space - Page 9



The length of a shadow can help us tell the time of day. At noon, the sun is almost overhead. The shadow is short. Check this measurement with your ruler. In the morning or afternoon, the shadow is much longer. Check the length of the shadow for various times of the day.

FORCES - SINGLE

FORCES AT WORK Prentice Hall 1965
Board of Education - Page 19

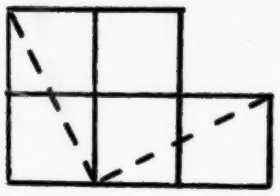


A force is a push or pull in a specific direction. When this force is able to move an object, work has been done. Work is the result of a force acting over a given distance. For example, a force 10 pounds that moves an object 2 feet has done 20 foot-pounds of work. An arrow can be used to show the effect of a force for a given distance. The example above shows a force of 40 pounds that has been drawn to scale to show 10 pounds for every half an inch.

MEASUREMENT - AREA

Joseph Leeming
J.B.Lippincott Company - Page 90

FUN WITH PENCIL AND PAPER



Can you make one large square out of five equal squares? Use your ruler to draw five equal squares as shown above. Cut out the five squares into one piece of paper. Now cut the figure along the dotted lines. You can now rearrange the three pieces to form one perfect square. Verify this fact by measuring each figure with your ruler. Notice that the area of the five small squares is the same as the area of the one large square.

MEASUREMENT - AREA

Vol.2 No. 1
September 16, 1965 - Page 11

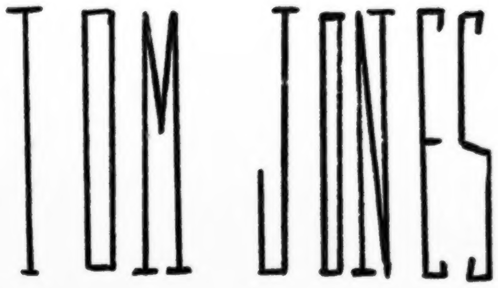
SCIENCE WORLD

Can you make an object double its size or area? Look at a picture on the far wall of a room. Place your index finger vertically in front of your eyes. When you look at the picture, your finger seems double. When you look at your finger, the picture seems double.

MEASUREMENT - AREA

Joseph Leeming
J.B.Lippincott Company - Page 76

FUN WITH PENCIL AND PAPER

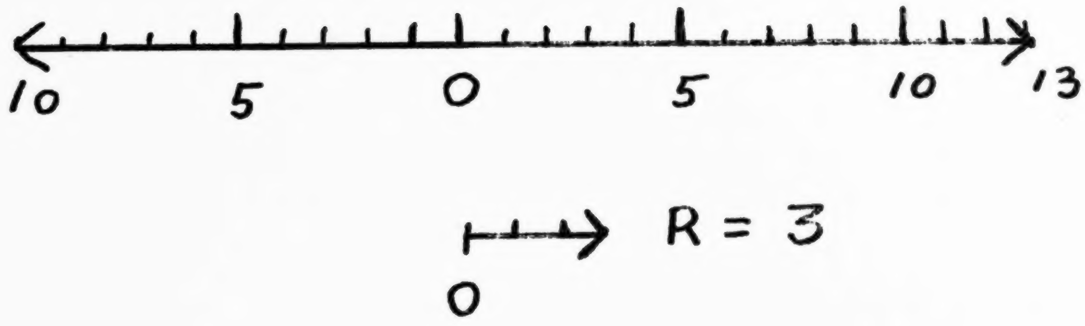


Skeleton printing uses long thin letters that are almost impossible to read in the usual reading position. You can read these letters easily if you view the letters at a low angle. In this position, the tall letters take up less viewing space on the retina (film) of the eye. The letters appear to be of normal height. Why is this type of lettering used on street pavements? How would this be helpful to drivers and pedestrians?

FORCES - COMBINED

FORCES AT WORK

Prentice Hall 1965
Board of Education - Page 21

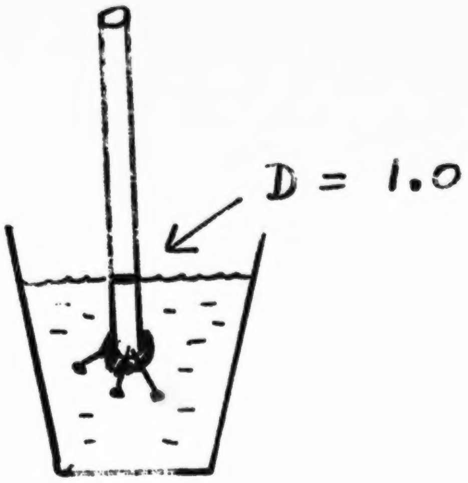


When two forces act at the same time in opposite direction, the result is the difference between the two single forces. This idea is best understood by thinking of a tug of war. If the force on the left is 10 pounds and the force on the right is 13 pounds, the result is a force of 3 pounds. The direction of this result is to the right because the greater force is on the right side. You can prove this fact by using two spring scales and watching the result when one force is made larger than the other.

DENSITY

EXPERIMENTS WITH MACHINES AND MATTER

Harry Sootin
W.W. Norton and Company, Inc., 1963
Pages 78-79



SODA STRAW HYDROMETER - Use a regular soda straw sealed at one end with hot wax. Carefully insert pins into the wax until the straw floats upright in cool pure water. Use a crayon to mark the exact level of the water on the straw. This level indicates a density of 1. Other liquids can be calibrated to increase the range of this hydrometer. Check your readings against the readings given on a laboratory hydrometer.

HOW OUR BODY WORKS

A. DIGESTION

LESSON 1. Can I stay healthy eating only candy?

OUTCOMES:

1. The body needs a variety of foods.
2. Foods may be grouped by how they work in the body.

PROCEDURE:

1. To arouse pupils' curiosity about how the body works, ask such questions as , "How is the human body different from a car?" Point out that a car can function very well using gasoline. Ask the question, "If we had only one food could we function as well?"

2. To direct pupil attention to the need for different foods, ask, "What is in food that makes it so important to us?" Lead the discussion to include the following: Carbohydrates, Sugar, Protein, Vitamins and Minerals and Water. Write these names on the chalkboard.

3. Ask the students for the names of some of their favorite foods. Write their suggestions on the board. Have the students copy the food nutrient titles that appear on the board. Point out that these are called nutrients. Guide the students into placing the foods they have named in the proper group. Ask for a volunteer to do it on the board.

4. Lead a discussion around the question, "What do you think of the school lunch?" Elicit that the school lunch contains a little bit from each food group so that it is a balanced diet.

5. Distribute the Pupil Food Chart and Work Sheet. Encourage the students to begin to answer some of the homework questions on the Work Sheet. Guide them to understand what they have to do.

SUMMARY:

1. Why is it important to have a diet that contains a little from each food group?
2. What are some of the things that food contain?
3. How is the human body different from a car?

HOMEWORK:

1. Make up a menu for 2 days that you think is a good diet. Place it on your Work Sheet. Use your Food Sources Chart to help you.
2. Ask to see your mother's shopping list or ask her what she will buy the next time she goes shopping. Try to list the foods your mother buys in the proper food groups that you learned in class. Put the answers on your Work Sheet. Decide whether these foods make up a balanced diet. How would you improve on it?
3. What are nutrients?

FOOD SOURCES CHART

Food Substance	Food Sources
Starch	bread, cake, rice,spaghetti, potatoes, cereal
Fats and oils	milk, butter, bacon, lard, corn, peanuts, chocolate
Sugar	fruits, candy, cakes, raisins
Protein	meats, fish, eggs, nuts, beans, milk, bread, corn, cheese
Vitamins:	
A	milk, butter, fish liver oils, yellow vegetables
B_1	pork, liver, peas, beans, fruit, vegetables
B_2	milk, eggs, liver
C	citrus fruits
D	liver, eggs, milk, salmon
Minerals:	
Calcium	milk, cheese, leafy vegetables
Iron	liver, red meats, enriched bread

PUPIL WORKSHEET

(May be duplicated for use by pupils)

Lesson 1. How can I plan a menu which will help me keep healthy?

1. Plan a menu for two days that you think will give you a well-balanced diet. Write it down in the table below.
   Use the Food Sources List to help you pick the foods for each meal.

MENU

	Breakfast	Lunch	Supper
First Day Menu			
Second Day Menu			

2. Ask your mother what foods she will buy on her next shopping trip. See if you can list the foods in the proper group in the table shown below. You may list the same food in more than one place.

Food List

Starch	Sugar	Fats & Oils	Protein	Vitamins & Minerals

A. DIGESTION

LESSON 2. How can we find out what nutrients are in our food?

OUTCOMES:

1. Some chemicals change color when they are added to a particular nutrient.
2. There are different tests for the different nutrients.
3. Foods are grouped according to what they do in the body.

MATERIALS:

test tubes with rack and holders
solutions of Lugol's, Biuret's and Benedict's
stirring rod
alcohol lamps and matches
cooked egg white
bread and raisins
unknown solutions of starch, sugar and protein solutions
(labeled unknown 1, 2, 3)

For protein solution use mascerated cooked egg white. For sugar solution use 5 tablespoons of Dextrose per 1000 milliliters of water. For starch suspension use corn starch dissolved in 1000 milliliters of warm water.

PROCEDURE:

1. Review briefly the learnings developed in the last lesson relating to the different food groups and the importance of a balanced diet.

2. Tell pupils that they are going to see how a scientist tests food to find out what nutrients the food contain. Demonstrate the different nutrient tests stressing the various techniques.

3. Write the procedures on the chalkboard.

   a) To Test for Starch
   Place a small piece of bread in a test tube. Add Lugol's Solution. A purple or black color indicates the presence of starch.

   b) To Test for Sugar
   Add a small amount of water to a few raisins in a test tube. Add Benedict's Solution and heat gently. Do not allow the solution to boil. The appearance of a brick-red color indicates the presence of sugar.

   c) To test for Protein
   Using a sample of mascerated egg white in water, add a few drops of Biuret's Solution. A pink or violet color indicates the presence of protein.

4. Distribute pupil worksheets and equipment to groups of pupils. Give each group one of the three (1 - starch; 2 - sugar; 3 - protein) unknown samples. Explain that each group is to do the three nutrient tests to find out what nutrient is in their sample.

NOTE:

For the next lesson, you will need Daphnia (water fleas). They can be obtained from any pet shop.

SUMMARY:

Following the pupil experiment, encourage pupils to explain how they used the different tests. Elicit suggestions from pupils as to why the chemicals they used are good to show them what nutrients the foods contain.

HOMEWORK:

1. If you are playing a game of basketball and you suddenly become very tired, how could you get some quick energy?

2. What do we mean when we say, "You are what you eat?"

3. If you were a food scientist and you were asked to find out what nutrients are in a sample given to you, explain what tests you would make. Write down the names of the test chemical and what happens when you test for the nutrients.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 2. How can I test for the different nutrients?

MATERIALS:

test tubes with rack and holder
alcohol lamp with matches
unknown sample
dropper bottles of Lugol's, Benedict's and Biuret's solutions.

PROCEDURE:

1. You will perform 3 food tests on the unknown sample you have to find out which nutrient it contains.

2. Place a small amount of unknown into 3 test tubes. Use the food tests that your teacher has explained. Fill in the worksheet as you go along with each test.

Unknown # ________________

	Chemical Tested With	What Happened?	What Nutrient Is Present
Test 1			
Test 2			
Test 3			

1. My results show that my unknown has ____________ nutrient.

2. Write down the chemical used to test the nutrient shown:

   a) sugar __________________

   b) protein __________________

   c) starch __________________

3. Why is it important to know what nutrients are in different foods?

A. DIGESTION

LESSON 3. How is your digestive system like an assembly line?

OUTCOMES:

1. The parts of the digestive system are the salivary glands, mouth, esophagus, stomach, small and large intestines, liver, gall bladder and pancreas.
2. The digestive tract is a tube open at both ends.
3. All the parts of the digestive system work togetner for proper digestion.

MATERIALS:

4 or 5 microscopes
depression slides
medicine droppers
daphnia (water fleas)
yeast culture stained with neutral red
wall chart of digestive system

Note: Add neutral red stain to yeast culture at beginning of lesson.

PROCEDURE:

1. Motivate the lesson by displaying a wall chart of the digestive system and asking for pupil volunteers to trace the path they think that food takes in the body. Tell the pupils that in order to study our system we are first going to look at the digestive system of a simple animal.

2. Organize pupils into small laboratory groups. Set up the microscopes under low power and distribute pupil worksheets. To the container of daphnia add a yeast culture that has been stained with neutral red at the beginning of the period. Distribute medicine droppers and depression slides to each group. Demonstrate to the pupils how to remove one daphnia with a little water. Have it placed on the slide and placed under the microscope under low power. Have pupils then compare their observations with the diagram of the water flea on their worksheets.

3. Guide the pupils in making the following observations:

   a) Food enters the mouth and is squeezed down into the digestive tube.

   b) The food tube is a continuous tube with openings at both ends.

   c) The parts of the simple animal can be compared to the parts of the human digestive system.

4. Distribute prepared diagrams of the digestive system with blank spaces for labeling. Have them label the parts following identification on the wall chart. List these on the board.

SUMMARY:

1. Why is the digestive tract called a food tube?
2. What are the parts of the digestive system?
3. What must happen to food in the food tube so that it can get to the other parts of the body?

HOMEWORK:

1. Complete labeling your diagrams on the parts of the digestive system.

2. How does food move through the food tube?

3. What do you think is the job of the digestive system?

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 3. What are the parts of the digestive system?

MATERIALS:

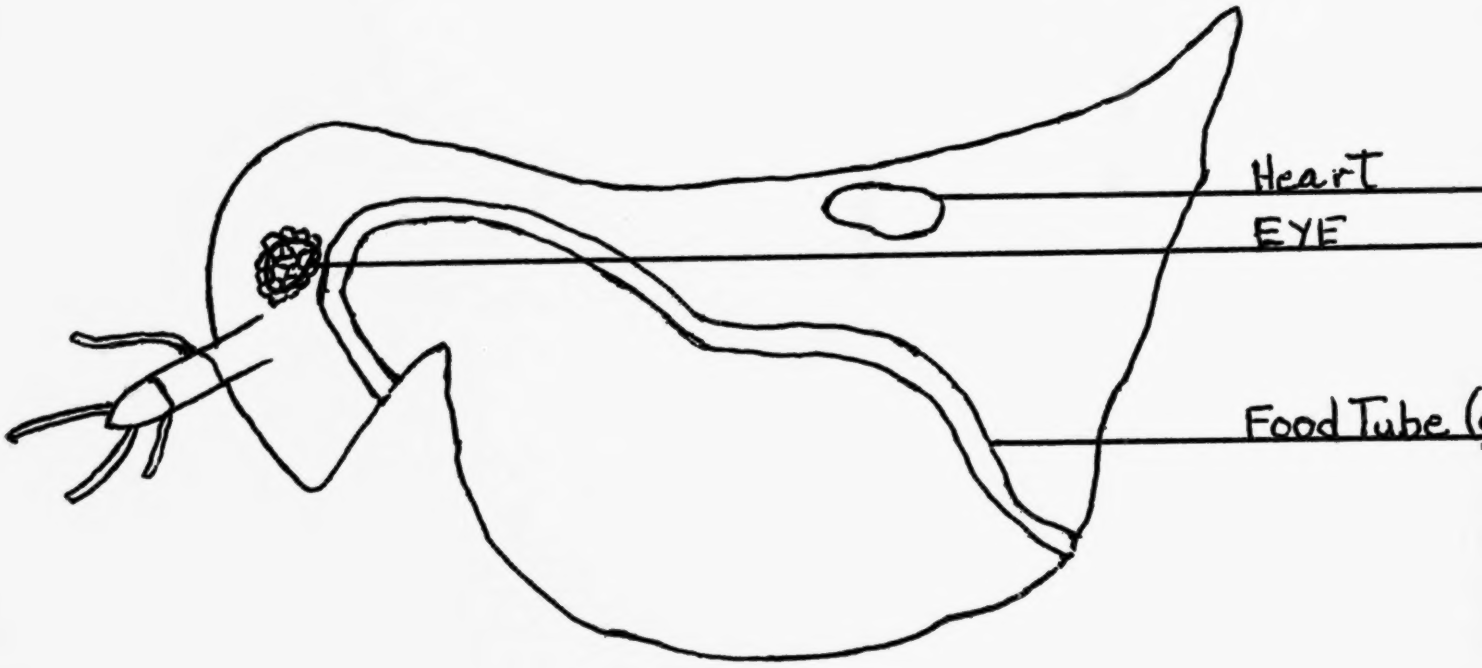
microscope
depression slides
daphnia (water flea)
medicine dropper

PROCEDURE:

1. Follow your teacher's instructions on how to place a water flea (daphnia) on a depression slide and place it on the microscope under low power.

2. The food for the flea has been stained so you can see what happens to the food as the water flea eats. Notice the different parts of the body. Compare this with your diagram of the water flea.

3. Watch the food move through the animal.

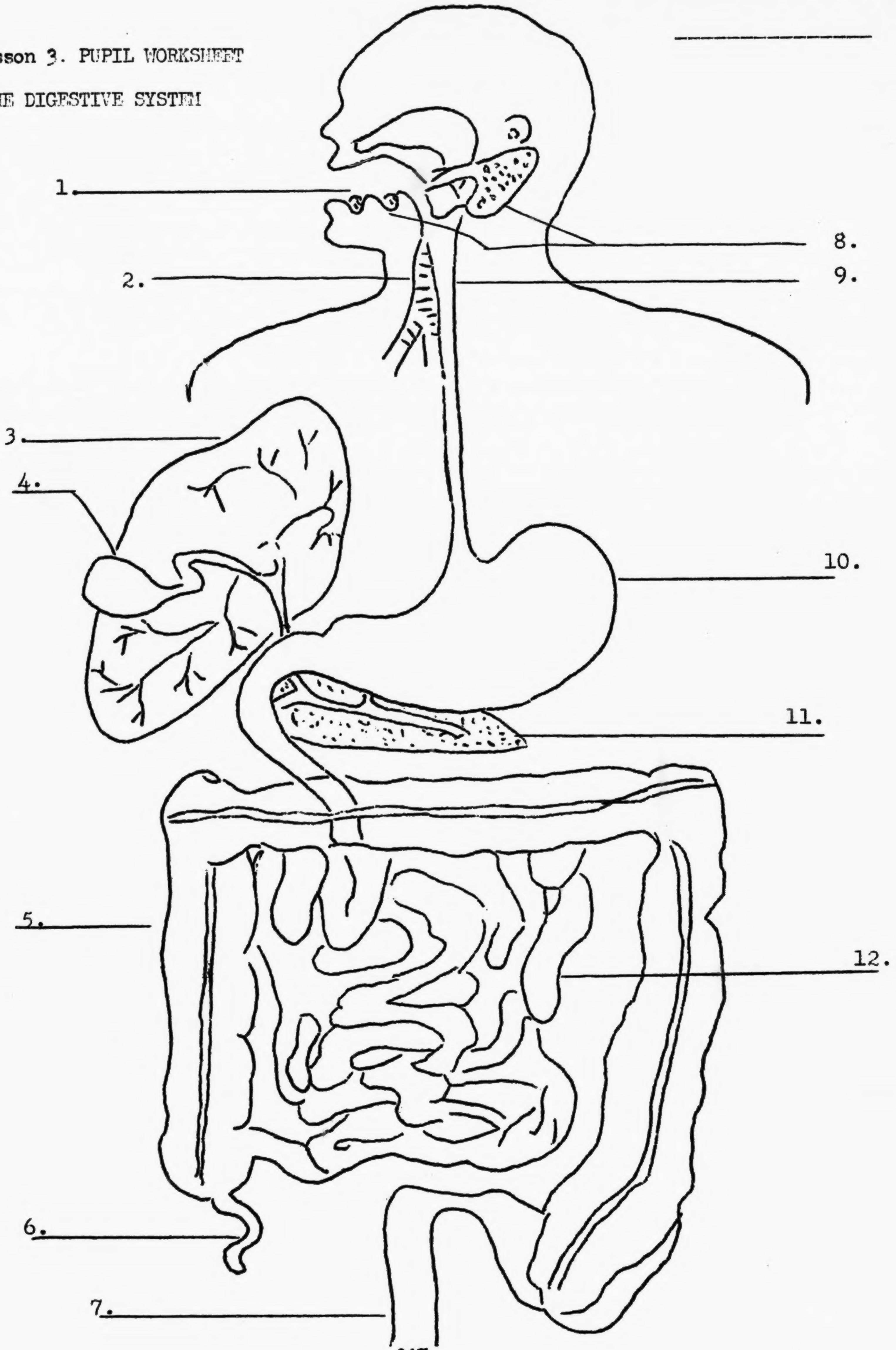


SUMMARY:

1. What makes the food move through the body of the water flea?
2. Why is the gut called the food tube?

Lesson 3. PUPIL WORKSHEET

THE DIGESTIVE SYSTEM


1.
2.
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12.

A. DIGESTION

LESSON 4. What happens when we chew our food?

OUTCOMES:

1. Digestion of food begins in the mouth.
2. Saliva moistens our food as well as changes starch to sugar.
3. Our teeth help grind our food into small pieces so we can digest it easier.
4. The tongue is used to move food around.

MATERIALS:

marble chips
powdered marble
2 large beakers
a thick piece of wood
wood shavings
test tubes
test tube rack
matches
starch solution
Benedict's solution
dilute hydrochloric acid
alcohol lamp
diagram of inside of mouth
test tube holder

PROCEDURE:

1. Review briefly the parts of the digestive system from the previous learnings. Motivate this lesson by adding some dilute hydrochloric acid to some marble chips in a beaker and some powdered calcium carbonate (ground chips) in a second beaker. Have the pupils note the time it takes for each to dissolve. Ask pupils to suggest ideas why the crushed marble dissolved faster,elicit that the smaller pieces dissolved faster. Lead the pupils to discover that the smaller the pieces, the more acid can reach it at one time. To reinforce this concept demonstrate by trying to light a thick stick as compared to wood shavings. Have the pupils note the time it takes for each to catch fire.

2. Relate this to chewing food and ask pupils to describe what is happening in the mouth. List the steps on the chalkboard. Lead the discussion to include the role of the teeth in grinding the food; saliva to moisten and change the food and the tongue to mix or push the food.

3. Distribute material and worksheets to small groups. Ask the pupils to supply their own saliva for this experiment (see pupil worksheet). Show them how to stimulate the flow of saliva by pushing down with their tongues.

4. After the pupils have done the experiment, introduce the terms mechanical and chemical digestion. Explain that the chemical in saliva helps to change the starch into sugar. This chemical is called ptyalin.

SUMMARY:

To reinforce the ideas about digestion, ask the following questions:

1. Why must food be broken down into small pieces before the body can use it?
2. What structures in the mouth help with digestion?
3. What is digestion?

HOMEWORK:

1. Chew a piece of bread for 3 or 4 minutes. How does the bread taste in your mouth? Why did the taste change?

2. Why should you chew your food carefully before swallowing it?

3. What is the difference between chemical and mechanical digestion?

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 4. What does saliva do to food?

MATERIALS:

test tubes
test tube rack and holder
Benedict's solution
saliva
alcohol lamp
matches

PROCEDURE:

1. Recall the nutrient tests for sugar and starch.
2. Fill 2 test tubes $\frac{1}{4}$ way with starch solution. Label the test tubes 1 and 2.
3. To test tube number 2 add some saliva and heat it gently. Let it stand. To a separate test tube add only saliva. Label this number 3.
4. To test tube number 1 perform the sugar test by adding a few drops of Benedict's solution. Heat it gently. Was there any sugar present? Place your answers on the worksheet table.
5. Do a sugar test with Benedict's solution on test tube number 3 containing only saliva. Was sugar present? Record your answer.
6. Perform the sugar test with Benedict's solution on test tube number 2. Heat gently without boiling. What did you find in this test tube?

Test Results Table

Test tube sample	Chemical used	Nutrient I found
# 1		
# 2		
# 3		

SUMMARY:

1. Does saliva contain starch? Sugar?
2. What is the test for sugar?
3. What happens when we add saliva to starch?

A. DIGESTION

LESSON 5. Can you swallow if you are standing on your head?

OUTCOMES:

1. Food moves down the esophagus to the stomach by peristalsis. Peristalsis is a series of muscular contractions (pinchings or squeezings) of the esophagus.
2. Peristalsis usually moves the food in one direction.
3. Food is stored in the stomach.

MATERIALS:

Teacher

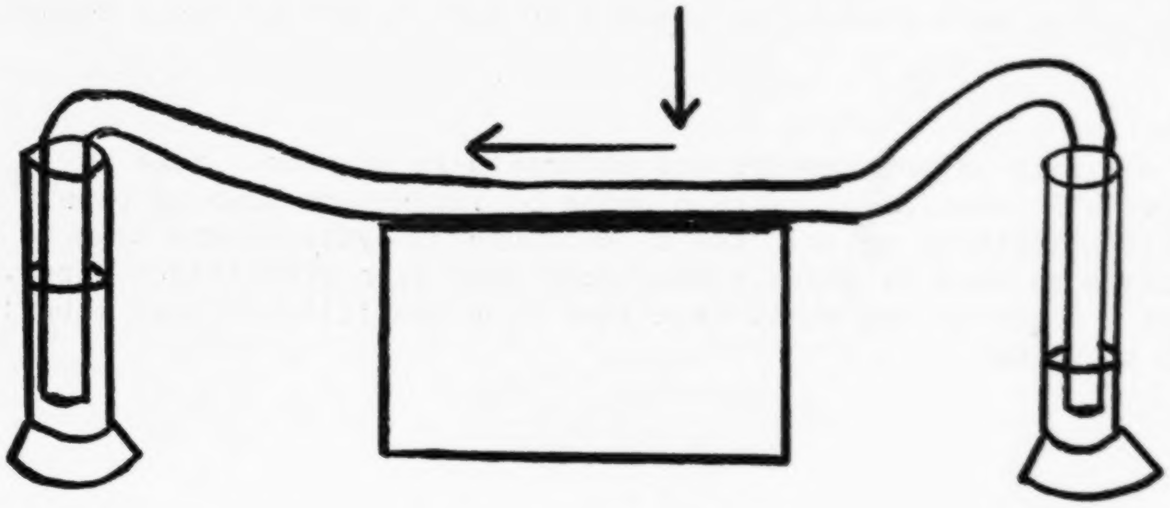
two 250 milliliter graduated cylinders
1 long section of rubber tubing

Pupil

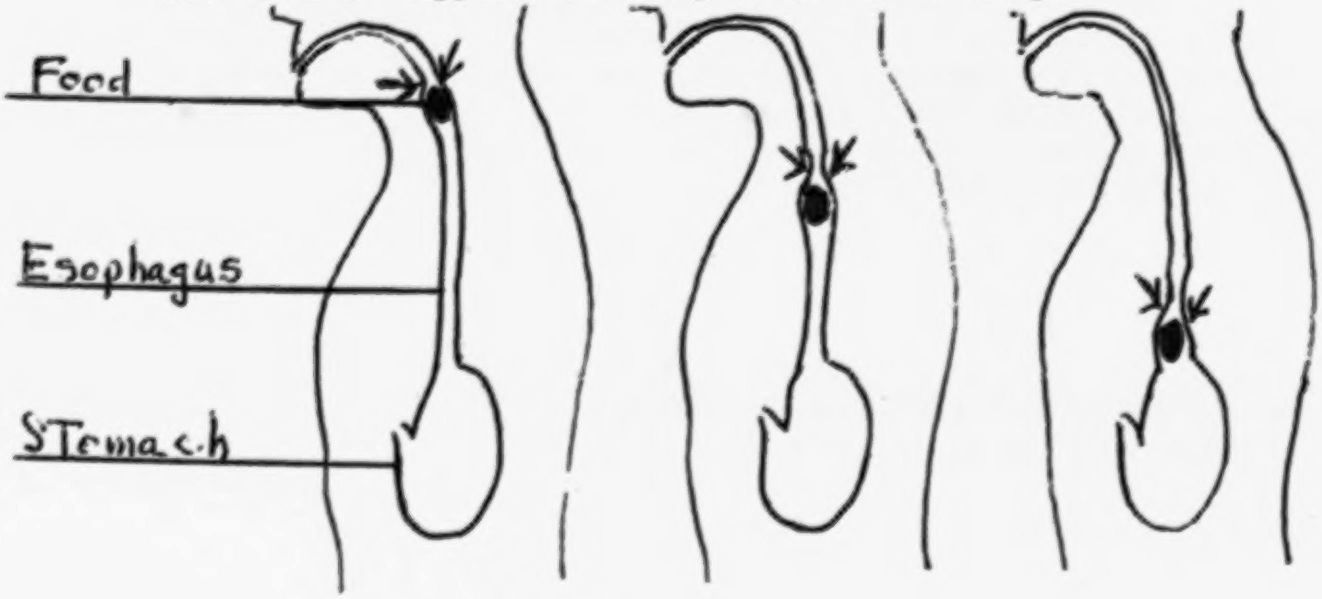
several long balloons
ring stands with clamps
string

PROCEDURE:

1. Motivate the lesson by setting up the demonstration as diagramed below. Place equal amounts of water into 2 graduated cylinders. Fill a long strip of rubber tubing with water and place either end into a graduate cylinder. Support the center of the tubing so that it doesn't sag. By siphon action the water in the 2 cylinders will remain equal. Challenge the pupils by asking, "How can we get the water to move from one cylinder to another?" Lead the pupils to realize that by squeezing the tube the water can be made to move. Referring to the ice pops that come in small plastic pouches and are frozen, ask, "How can we get the ice pop out?"



2. Have the pupils refer to their diagrams of the digestive system. Give them time to think through the question, "How does food get from our mouth to our stomach?" Lead the pupils to understand the term peristalsis as the wave-like motion of the muscles. Explain that peristalsis usually works in one direction. Ask, "What do you think would happen if peristalsis worked backwards?" Elicit that this is what happens when they vomit or throw-up.



3. Distribute worksheets and materials to the pupils. Guide them in following the procedures on the worksheets. In this experiment the pupils will be guided in finding how the process of peristalsis must occur in order to push the food into the stomach. By means of a balloon containing water and suspended from a ringstand, the pupils will "see" how the contractions (squeezing or pinching) will begin on top and move as a wave down the length of the food tube.

SUMMARY:

After the pupils have finished work, summarize by concluding that food reaches the stomach by peristalsis and that food is stored in the stomach. Conclude that peristalsis begins at the top of the esophagus and pushes down. This helps us swallow food even if we stand on our heads. To see if pupils really understand the operation of peristalsis ask them to explain in their own words whether food would still move toward the stomach if they "stood on their heads".

NOTE:

For the next lesson prepare the materials in advance. Make a solution of artificial gastric juice by mixing one gram of pepsin in 50 milliliters of water. Add a few drops of hydrochloric acid to the solution so that it gives a weak acid test with blue litmus paper. Place a piece of egg white on a test tube and fill the test tube 1/3 full of water.

Place a second piece of egg white in another test tube and add the same amount of artificial gastric juice. Leave the test tubes overnight in a warm place.
Also, obtain a section of tripe from any butcher shop for pupil observations regarding the structure and texture of the stomach lining.

HOMEWORK:

1. What is peristalsis?
2. Why can astronauts swallow food in space?
3. Why is it important to have peristalsis work in only one direction?
4. Why is the stomach sometimes called a storage place?

(The words required in question 10 on the pupil worksheet are: peristalsis, esophagus, contraction)

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 5. How does food move through your food tube (esophagus)?

MATERIALS:

long balloons
ringstand with clamp
string

PROCEDURE:

1. To a long balloon, add about 50 milliliters of water. Your teacher will show you how much this is in the glass cylinder. Tie off the open end of the balloon and suspend it from the clamp on the ringstand.

2. Squeeze the balloon with your hand in the middle. Describe which way the water moved. ______________________________
   Is this the way water could be pushed down into the stomach? Why?
   ____

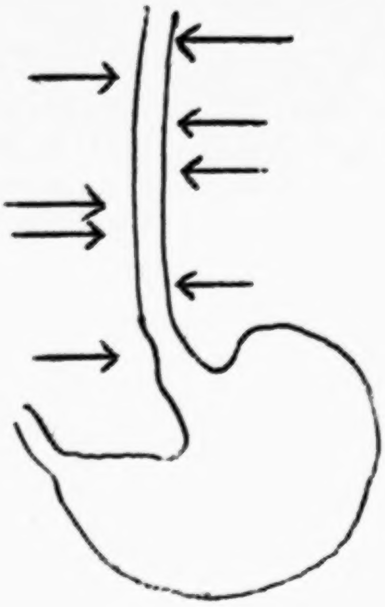
3. Squeeze the balloon at the bottom. Which way did the water move?
   ____

4. Squeeze the balloon at the top. In which direction did the water move?
   ____

5. What would happen if peristalsis started at the bottom and moved up?
   ____
   ____

6. Why do you think peristalsis must start at the top? ______________
   ____
   ____

7. Thinking question: Below is a picture of the food tube (esophagus) and the stomach. Small arrows are placed at different points. Put a number 1 next to the arrow where you think the squeezing (peristalsis) must begin. Put a number 2 near the arrow where you think is the next squeezing or pushing point. Continue until all the arrows have a number.



8. What would happen if the entire food tube (esophagus) contracted at once?

____

____

9. When you want to get toothpaste out of a tube, where do you start to squeeze? (Bottom? Middle? Top?) ____________________

10. What new words did you learn in this lesson? Write the words on the lines below and tell what they mean:

p _ _ _ _ _ _ _ _ _ _ ______________________________

e _ _ _ _ _ _ _ _ ______________________________

c _ _ _ _ _ _ _ _ _ _ _ ______________________________

A. DIGESTION

LESSON 6. How does your stomach change solids to liquids?

OUTCOMES:

1. The stomach gives off a liquid called gastric juice. The gastric juice moistens the food and helps break down proteins in the stomach.
2. Peristalsis helps to break down food by mixing it with gastric juice.
3. When food leaves the stomach it is in a semi-liquid form.

MATERIALS:

Teacher

wall chart of stomach and small intestine
solution of pepsin, hydrochloric acid, egg white, prepared as directed in the previous lesson

Pupil

hand lens
fresh tripe
hardboiled egg white
powdered pepsin
dilute hydrochloric acid (1:10)
graduated cylinder
test tubes and rack
stirring rods

PROCEDURE:

1. Display the demonstration of the effects of gastric juice on protein that was indicated in the previous lesson. Explain how you set this up. Outline on the board what was present in both test tubes. Ask the pupils what they see in each of the test tubes. Ask for suggestions about what took place. Lead the pupils to discover that gastric juice and hydrochloric acid changes food into a liquid by breaking down the egg white (protein).

2. Guide the pupils in recalling how peristalsis helped to push the food down the food tube. Elicit that peristalsis can speed up the mixing of food with the gastric juices.

3. Display the wall chart of the stomach. Distribute small pieces of tripe and a hand lens to groups of pupils. Have them examine the specimen. Tell them that tripe is the stomach lining of a hog. Have them notice the moist appearance and the wrinkled surface of the tripe. Explain that gastric juice is given off from this lining. Relate the tripe to the diagrams on the wall chart. Collect the materials.

4. Tell the class that they will now test the effect of gastric juice on (protein) egg white. They will also see the effects of heat on digestion. Distribute pupil materials and worksheets. Guide the pupils in preparing artificial gastric juice as you have already done.

5. After the pupils have set up the experiment collect the materials and store 1 test tube of gastric juice and egg white from each group in a cool place. Store the others in a warm place.

SUMMARY:

Summarize the new ideas by having the pupils realize that gastric juice is essential for protein digestion. Have them discuss the effect that peristalsis has in the stomach.

NOTE:

For lesson 7 prepare a solution of artificial pancreatic juice by mixing one gram of pancreatin , (obtained from lab assistant) and 2 grams of baking soda in 50 milliliters of water. Test the solution with red litmus to make sure it has a weak basic reaction. It should turn slightly blue. Place a few drops of oil in a test tube and fill it about 1/3 full of water. Place the same amount of oil in a second test tube and add the same amount of artificial pancreatric juice. Leave the tubes overnight in a warm place.

HOMEWORK:

1. Name some foods that have a lot of protein.
2. Explain what happens to one of these foods in the mouth and stomach.
3. Compare peristalsis in the food tube to peristalsis in the stomach.
4. What is the effect of heat on protein digestion?

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 6. What does gastric juice do to proteins?

MATERIALS:

hard boiled egg white
test tubes and rack
dilute hydrochloric acid
rubber bands
graduated cylinders
stirring rods
powdered pepsin

PROCEDURE:

1. Following the teacher's instructions prepare a test tube of artificial gastric juice.

2. Label 4 test tubes number 1,2,3,4.

3. Into test tubes 1, 2, and 3 place chopped egg white. Into test tube 4 put larger pieces of egg white. Add the gastric juice to test tubes 1, 2, and 4. To test tube 3 add water.

4. Place a rubber band around test tubes 1, 2, and 4. Put your group number on it and give it to your teacher. These will be placed in a warm area overnight. Give test tube 3 to your teacher. This will be kept in a cold place overnight.

5. Answer the questions on the worksheet. Some of these questions you will have to answer tomorrow when your teacher returns your materials.

6. Which test tube will have the greatest change? ____________________
   ____

7. What did test tube number 3 represent? ____________________
   ____

8. What effect did the size of the egg white have on the experiment?
   ____

9. What effect does heat have on digestion? ____________________
   ____

A. DIGESTION

LESSON 7. Why do we have a 20 foot tube inside our body?

OUTCOMES:

1. Pancreatic juice aids in digestion.
2. Bile is made in the liver and stored in the gall bladder. Bile helps us digest fats.
3. Digestion is completed in the small intestine.
4. The small intestine is about 20 feet long. It is called the small intestine because it is narrower than the large intestine.
5. Digestion takes place faster when the food is small and there is a warm temperature.

MATERIALS:

Teacher

wall chart of small intestine
solution of pancreatin, baking soda and water
a small cardboard box
a 10 foot length of tubing

Pupil

dropper bottles of oxgall(bile), oil and water
depression slides
microscopes
test tubes with rack
corks
marking pencils

PROCEDURE:

1. Have the pupils examine the demonstration of pancreatin to was indicated in the previous lesson. Explain and outline on the board how it was set up. Ask the pupils to describe the results in both test tubes. Lead them to realize that pancreatin breaks up the oil so that it is mixed with the liquid. Guide them to realize that digestive juices and warmth help speed up digestion.

2. Display a wall chart of the small intestine. Ask the pupils if they have ever eaten "chitlings". Tell them that "chitlings" are made from the small intestine of a pig.

3. Ask them how we can fit a 20 foot long intestine into our body. Display a 10 foot length of tubing and a small box. Have a volunteer fit the tubing into the small box. Conclude that the small intestine is coiled. If the small intestine is 20 feet long, why is it called small? Lead them to discover that the diameter of the small intestine is narrower than the diameter of the large intestine.

4. Have the pupils locate on the chart the liver, gall bladder, and pancreas. Explain that the liver makes bile and that it is stored in the gall bladder. The gall bladder puts this liquid into the small intestine through a tube. Tell them that the pancreas also puts its digestive liquids into the small intestine through a tube.

5. Distribute pupil worksheets and materials. Set up the microscopes earlier under low power. Guide the pupils in preparing depression slid slides and other laboratory materials.

SUMMARY:

Summarize by having the pupils realize that digestion is now completed in the small intestine. Have them recall the different foods that have been changed. Guide the discussion to include the names of these foods. Explain that heat can speed up digestion. Relate the length of the small intestine to the amount of digestion that takes place in it.

HOMEWORK:

1. How is bile important in the digestion of fat?

2. What kind of foods are digested in the small intestine?

3. How does the small intestine fit into our bodies?

4. Why is digestion necessary in living things?

5. How does food size and heat affect digestion?

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 7. What does bile do to fat?

MATERIALS:

dropper bottles of a - bile, b - oil, c - water
depression slides
microscope
test tubes with rack
marking pencil
corks

PROCEDURE:

1. Mark two test tubes 1 and 2. Fill the first 1/2 full with water. Fill the second 1/2 full with bile. Add a few drops of oil to each test tube.

2. Cork the first test tube and shake it. What happened to the oil?

   ____

3. What do we call this kind of mixture? (solution, suspension, emulsion) ____

4. Cork the second test tube and shake it. What happened to the oil?

   ____

5. Compare what took place in both test tubes.

   ____

6. Following your teacher's directions, place one drop of each liquid on a depression slide. Examine each one under the microscope under low power.

7. What differences did you notice between the two slides?

   ____

8. How does bile help digest fats?

   ____

A. DIGESTION

LESSON 8. How can a bump in the small intestine make it longer?

OUTCOMES:

1. Digested food enters the blood through the villi in the small intestine.
2. The villi are covered with a thin layer of cells called a membrane.
3. Inside the villi are three types of blood vessels, arteries, capillaries, and veins. The digested food enters the capillaries.
4. Because of villi in the small intestine the surface of the small intestine is larger so that more food can be absorbed into the blood vessels.

MATERIALS:

chart of small intestine showing villi
model of villus
rubber change mat (the type that has many rubber projections on it)
unlabeled diagram of villus

PROCEDURE:

1. Motivate the lesson by displaying the rubber change mat. Relate its appearance to the inside of the small intestine. Display a wall chart of the small intestine. Ask the pupils to describe its appearance. Elicit that the small intestine has many small projections (bumps).

2. Explain that these projections are called villi (plural), villus (singular). Distribute worksheet diagrams of the villus and guide the pupils in filling in the labels as the lesson proceeds.

3. Point out that the villus has a covering of cells called a membrane. Guide the pupils in locating and labeling the membrane on the diagram. Explain that the membrane is very thin so that it is possible for digested food to pass between the cells.

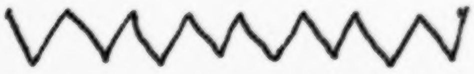
4. Have the pupils describe what the inside of the villus looks like. Elicit that it has a series of tubes. Tell them that these tubes are called blood vessels. Ask if anyone knows the name of any blood vessels. Write the names of the blood vessels on the board, (arteries, veins, and capillaries).

5. Describe the function of each of the blood vessels but not in too much detail, it will be covered in a later lesson.

   artery: carries blood away from the heart; carries blood with a lot of oxygen
   vein: carries blood to the heart; carries blood with very little oxygen
   capillary; join arteries and veins; this is where digested food enters the blood stream

Guide the pupils in labeling their diagrams.

6. Explain that the villi increase the surface area of the small intestine so that more food can be absorbed. To reinforce this concept of a larger area, draw the following two lines on the board.



Ask the pupils to tell which one is longer. Have them realize that line two represents the small intestine.

SUMMARY:

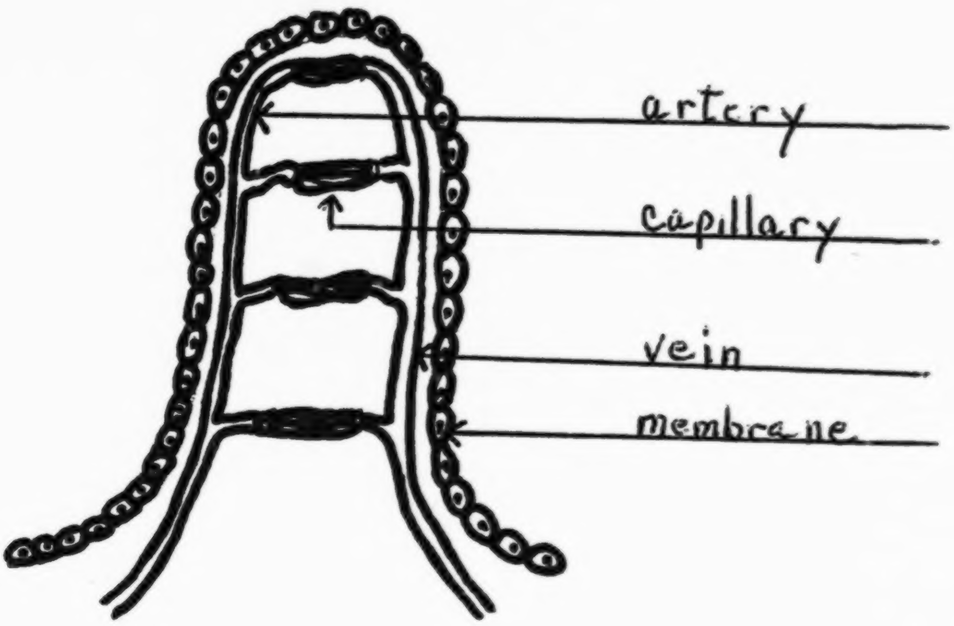
Summarize by asking the pupils the purpose of digestion. Guide them to realize that food must be made small enough to pass through the membrane of the villi. Lead the pupils to discover that the food that gives us energy and keeps us healthy is transported by blood vessels.

HOMEWORK:

Have them complete the diagram and begin answering the questions.

1. What is the job of the villi?
2. Why is the surface of the small intestine covered with villi instead of being flat?
3. How is a villus like a mouth?

Diagram of the Villus

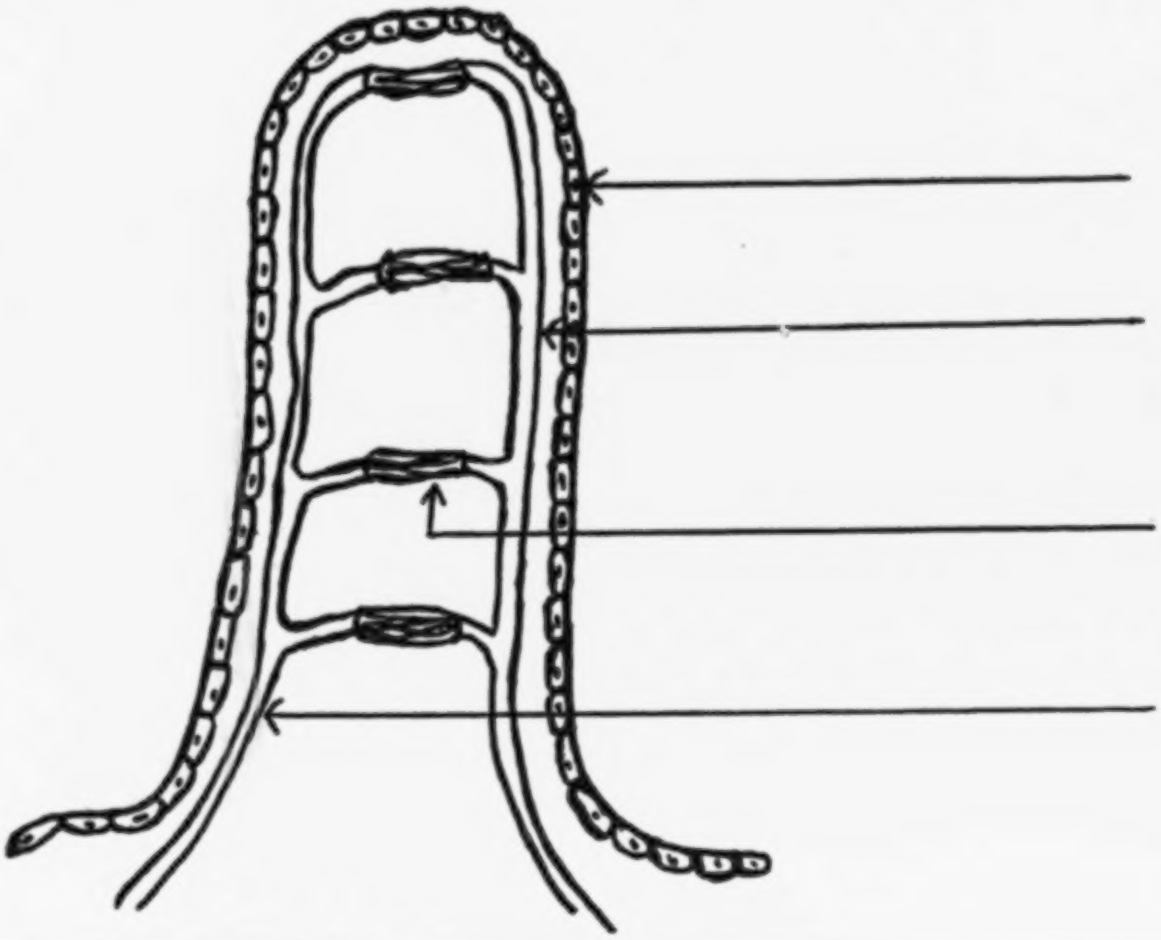


Note: For the next lesson please obtain outdated blood samples. These can be obtained from any hospital.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 8. How does digested food enter blood?

Villus



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1. Give 2 differences between an artery and a vein.
2. Why are capillaries important?
3. What do villi do for us?

B. CIRCULATION

LESSON 9. What is blood?

OUTCOMES:

1. Blood is a mixture of cells and chemicals in a liquid.
2. The solid and the liquid portions of the blood can be separated. One method is by centrifuging.
3. Digested (dissolved) food is carried by the liquid portion of the blood.
4. More than 50% of the blood is liquid which is called plasma.
5. The solid part of the blood is made of red blood cells, white blood cells, and platelets.

MATERIALS:

Teacher

centrifuge
chart of blood cells
outdated human blood (obtained from a hospital)

Pupil

test tubes with rack and test tube holders
alcohol lamps and matches
dropper bottles of Lugol's and Benedict's solution

PROCEDURE:

1. To motivate the lesson display a sample of outdated human blood obtained from a hospital and ask the pupils to describe it. Tell the pupils that aside from being a liquid it is also part solid.

2. Display the wall chart of the blood cells and show the solid portion as being the red and white blood cells.

3. Have the pupils recall that different methods of separating mixtures in chemistry. Lead the pupils to state that blood is a mixture of a solid with a liquid. Ask for possible ways to separate the blood. Introduce the centrifuge and explain how it works. Compare the centrifuge to some rides in Coney Island or Palisades that push you to the wall or car.

4. Distribute the pupil worksheets and have the pupils begin work as you proceed. Centrifuge a sample of blood and display it to the class. To centrifuge blood, place a half-filled test tube on one side of the centrifuge. Fill another test tube one-half full of water and place it on the opposite side of the centrifuge. The centrifuge with the balanced test tubes may now be started.

Have the pupils compare the results with the diagram on their worksheets. Guide them in labeling the plasma (liquid on top) and the cells (solid on bottom). Have them begin to answer the related questions.

5. Distribute a small sample of plasma to each group of pupils. Guide them in performing the nutrient tests of starch and sugar.

SUMMARY:

Have the pupils realize that blood is a mixture of a solid and a liquid. Based upon their test results have them discuss the job of the plasma. Also review what the solid portion of the blood is made of. Guide the pupils in understanding how each part of the blood takes part in maintaining our health.

HOMEWORK:

1. How does digested food get to your body cells?
2. What is the job of plasma?
3. What materials make up the solid part of the blood?
4. Why can't you substitute water for blood in your body?

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

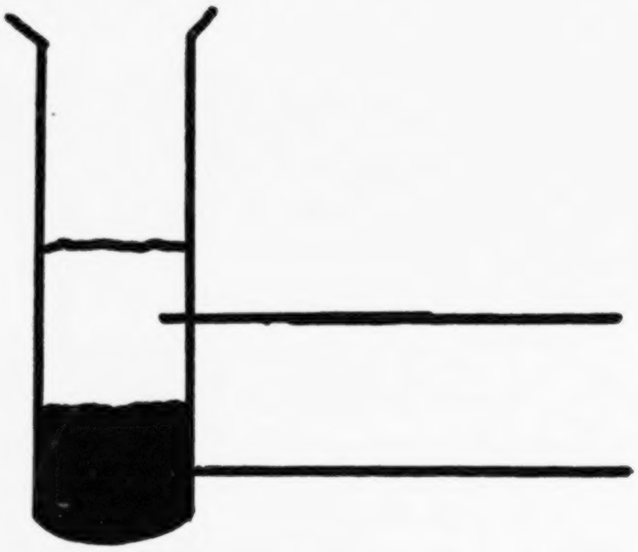
LESSON 9. What is blood made of?

MATERIALS:

test tubes with rack
test tube holder
alcohol lamp
dropper bottles of Lugol's and Benedict's solution
matches

PROCEDURE:

1. Label the following diagram of the centrifuge sample of blood.



a. The liquid portion of the blood is called ____________________.
b. The solid portion of the blood is made of

____________, ______________, and ___________________.

c. Is there more solid or liquid in the blood? _________________.

2. Recall the test for sugar and the test for starch. With the help of your teacher perform the starch test on a small sample of plasma. Was starch present? _______________

Now perform the test for sugar on a separate sample. Was sugar present? ________________

Based upon your test results, what is the job of the plasma? ______

____

B. CIRCULATION

LESSON 10. Where does "pus" come from?

OUTCOMES:

1. The solid part of the blood is made of red and white blood cells and platelets.
2. Red blood cells have a definite shape, lack a nucleus and carry oxygen and carbon dioxide.
3. White blood cells have no definite shape, have a nucleus and help fight germs.
4. There are more red cells than white.

MATERIALS:

Teacher

chart of blood cells

Pupil

prepared slides of human blood
microscope
lens paper

PROCEDURE:

1. The purpose of this lesson is to give pupils an awareness of how blood cells help to maintain health and fight germs. Although, reference is made to identification of cells, the stress should be placed on why they are important. Motivate the lesson by asking the pupils to describe a cut they have had. Elicit that around the scab they may have seen "pus". Tell them they are going to find out where this "pus" came from.

2. Distribute pupil materials and worksheets. Guide the pupils in observing the prepared slides of human blood under low power. Urge them to fill in their worksheets.

3. After the laboratory experience, outline on the chalkboard the differences between the 2 types of blood cells. Include in this review; size, shape, function, presence of nucleus, and color. Explain that a nucleus is the center of activity of the cell. Explain that the red cells are concerned with delivering oxygen to the body and picking up carbon dioxide, a waste, in return. The white blood cells are concerned with fighting germs in the body.

SUMMARY:

Conclude by having the pupils describe the differences that exist between red and white cells.

Ask them why was the nucleus of the white cell stained. Have them realize that the white cells fight germs. When the white cells die, it forms "pus".

HOMEWORK:

1. Describe 3 differences between the red and white blood cells.
2. Why do you think there should be more red cells than white cells?
3. How is "pus" formed?

NOTE: For a future lesson obtain a beef heart from a butcher.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

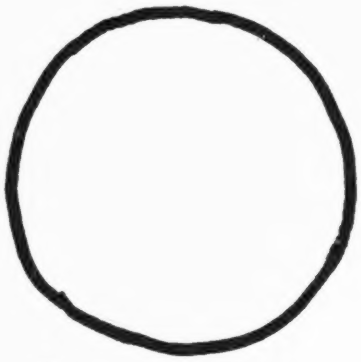
LESSON 10. Do all blood cells look alike?

MATERIALS:

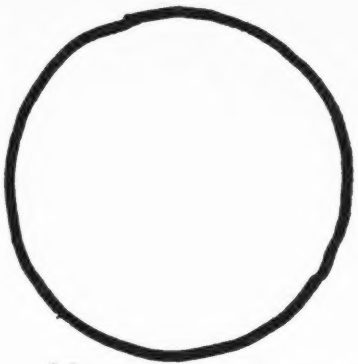
microscope
lens paper
prepared slides of human blood

PROCEDURE:

1. After preparing the microscope for use place a prepared blood slide under the microscope using low power. Draw what you see. Carefully change to high power and again draw what you see.



Low power



High power

2. Answer the following questions as you proceed.

   a. Move the slide around. How many different kinds of blood cells can you see? ______________________

   b. What is the shape of the red cells that you see? ____________

   ____

   c. Locate a cell with a dark spot in it. What is the shape of this cell? ______________________________

   d. What are 2 differences between the cells that you see? ______

   ____

   e. What kind of cells are most of those seen on the slide? _____

   ____

   f. Which cells of those you see are larger? ________________

HOW OUR BODY WORKS

B. CIRCULATION

LESSON 11. How does blood get from your head to your toes?

OUTCOMES:

1. Blood vessels are tubes that carry blood to all parts of the body.
2. There are three types of blood vessels; arteries, capillaries, and viens.
3. Arteries carry blood rich in oxygen away from the heart.
4. Veins carry blood poor in oxygen to the heart.
5. Capillaries, which are the smallest blood vessels, join the arteries and the viens.

MATERIALS:

Teacher

large glass slide
live goldfish and a fishnet
microscope
absorbent cotton
thread
chart of blood vessels

PROCEDURE:

1. Distribute pupil worksheets and instruct pupils to fill them in as we go along. To motivate the lesson wrap up the goldfish in wet absorbent cotton but leave the tail uncovered. Using the thread, tie the goldfish to the glass slide and spread apart the tail. Place the fish under the microscope using high power. Keeping the cotton wet, allow each pupil to come up and view the tail of the fish.

   Caution: Do not keep the fish out of the water for more than 10 minutes at a time. After all the pupils have seen the fish return it to the water.

   Tell the pupils that the very tiny blood vessels are called capillaries and that they join together the larger blood vessels.

2. Recall the previous work done with the villi. Have them recall the names of the other blood vessels. Write the names artery and vein on the chalkboard.

3. In order to have the pupils understand the movement of blood in arteries, show them how to take their pulse rate. Ask the pupils for possible reasons for this beat of the pulse. Elicit that there is blood moving through the arteries. Explain that arteries carry blood that has a lot of oxygen away from the heart. Ask the pupils why they think this occurs. Elicit that since the body needs oxygen the arteries deliver it to all parts of the body.

4. Have the pupils examine their arms. Have them describe the tubes they see. Elicit that they appear greenish blue in color and they are the viens. Explain that the veins carry blood with no oxygen but have a large amount of carbon dioxide.

SUMMARY:

Conclude by reviewing the names of the blood vessels. Have the pupils compare the function of the bloodvessels. Lead them to discover that blood only moves in the blood vessels which extend all over the body.

HOMEWORK:

1. How does an artery differ from a vein?

2. What are the smallest blood vessels?

3. Where do blood vessels take the blood?

4. What is meant by pulse?

5. Why do arteries appear to be red?

6. Why do veins look dark on our skin?

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 11. What are the three types of blood vessels?

PROCEDURE:

1. Look at the goldfish under the microscope. How many different blood vessels can you see? ____________________

2. What is the name of the small blood vessels? ________________

3. Following your teacher's directions, find your pulse. What is your pulse rate for 1 minute? _______________ What is your partner's pulse rate? ___________

   Whose pulse was faster? ____________________________________

   What do you think this means? _____________________________

4. Why should arteries carry blood with a lot of oxygen away from the heart? ____

   ____

5. Look for blood vessels on your arm. What kinds of tubes are these? __________________

   What color do they appear to be? ___________________________

B. CIRCULATION

LESSON 12. How is blood pushed around the body?

OUTCOMES:

1. We can listen to out heartbeat with a stethoscope.
2. Your heart is a pump that pushes blood through the blood vessels.
3. We can speed up the heartbeat by exercising.
4. Pulse rate and heartbeat are the same.
5. Heartbeat rates differ in different people.

MATERIALS:

Teacher

stethoscope

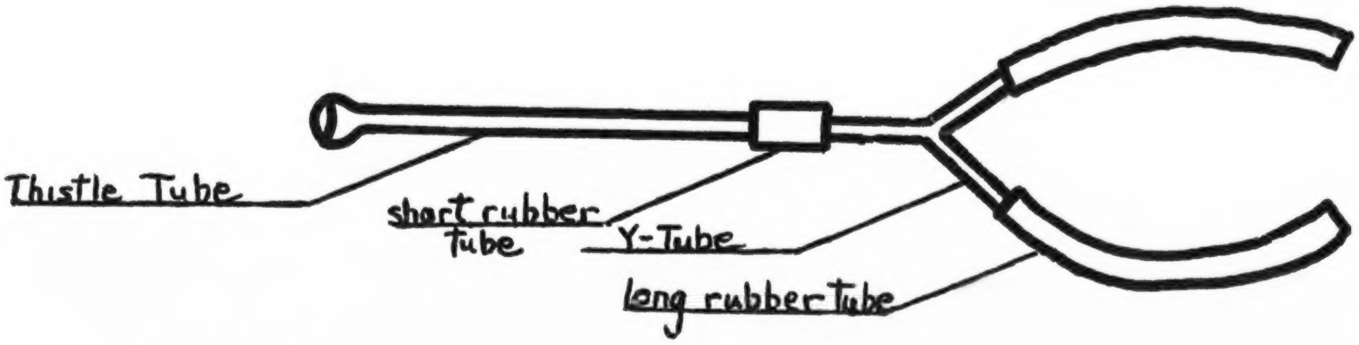
Pupil

stethoscope (if available)

Note: If a stethoscope is not available one can be made using the following materials: thistle tube, glass Y - tube, one short connection of rubber tubing, and 2 twelve inch pieces of rubber tubing (see diagram in procedure #2)

PROCEDURE:

1. In motivating this lesson ask the pupils to describe some things the doctor usually does when he gives them a physical checkup. Elicit that one of the things he does is to listen to their heartbeat. Ask the pupils how the doctor did this. Elicit that he used a device. Tell them that this device is called a stethoscope. Tell them that they are going to listen to their heartbeats.
2. To small groups of pupils distribute pupil worksheets and materials. If stethoscopes are not available, guide the pupils in constructing one, as illustrated in the diagram below.



3. After the pupils have listened to their heartbeats, ask them to describe what they hear. Ask them to think through the idea as to why the heart is beating. Elicit that the beating is caused by the heart squeezing together in order to push the blood around the body.

SUMMARIZE:

Summarize by asking if we can feel our heartbeat in our arms. Encourage them to find the areas of the body where a pulse can be felt - neck, wrist. Have the pupils compare their own heartbeat to their pulse. Have them realize that they are the same. Review the effects of exercise on the heartbeat. Ask the pupils why they think the heartrate increases with the exercise. Lead them to discover that the body needs more oxygen and energy when we exercise so that the heart must beat faster in order to deliver more oxygen and remove the carbon dioxide wastes.

HOMEWORK:

1. Take the pulse rate of each member of your family and compare them. Try to explain why some are higher than others.

2. Describe some ways we can increase our heartrate.

3. How can we feel our heartbeat in our arm?

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 12. How can we listen to our heart?

MATERIALS:

stethoscope (if available)
or
thistle tube
Y glass tube
2 twelve inch lengths of rubber tubing
1 small piece of rubber tubing

PROCEDURE:

1. If a stethoscope is available proceed to number 2. If you are going to make one follow these instructions. Fit the small piece of rubber tubing over the small end of the thistle tube. To the open end of the rubber tube fit the long stem of the Y - glass tube. To each branch of the Y - tube attach a 12 inch length of rubber tubing. Have your teacher check your work.

2. Place one end of each of the rubber tubes in your ears or if you have a regular stethoscope put it in your ears. Place the other end against your upper chest and listen for the sound of your heart. Describe the sound of your heart. ______________________________

3. Take your heartbeat for 1 minute. How many times did it beat? ______ Why do you think your heart makes this sound? ____________________

   ____

   Take your partner's heartbeat. How much was it? ________________

4. Recall how you took your pulse rate before. Take your pulse rate for 1 minute and record it. ______________ How does your pulse rate compare with your heartrate? ________________________________

5. Jump up and down 20 times. Have one of your partners take your heart rate and one partner take your pulse rate for 1 minute. How high was your pulse rate? ______________ Heart rate? ______________ Try and explain why it changed. Is your heartrate and pulse rate the same as your partner's? ________________ Why do you think they are different? ______________________________________

HOW OUR BODY WORKS

B. CIRCULATION

LESSON 13. What does your heart look like?

OUTCOMES:

1. Your heart is a pump that is divided into two halves. The right side pumps blood to the lungs and the left side pumps blood to the body.
2. Each side of your heart has two sections, one auricle and one ventricle.
3. Auricles receive blood and ventricles pump blood.
4. Valves stop blood from moving backward.

MATERIALS:

Teacher

beef heart obtained from a butcher
disecting tools
model of heart

Pupil

diagram of heart for labeling

PROCEDURE:

1. Distribute pupil worksheets and instruct the pupils in filling them in as you proceed.

2. Display a beef heart and ask the pupils to describe it. Tell them it looks similar to our heart. Display the model of the human heart and ask the pupils to describe it pointing out the similarities between both. Ask, "How can we find out what our heart looks like inside?" Explain that the beef heart will be cut open so that they can see the parts.

3. Make a latitudinal cut about one inch through the top portion of the heart. Expose the section and have the pupils describe how it looks. Elicit that you can see two small holes or openings and these openings are separated by a wall. Tell the pupils that these two sections are called auricles. Point out the corresponding part on the human model. Refer to the pupil diagram and indicate that the heart is divided into two halves. Ask the pupils what they think the job of the auricles is. Develop the idea that the job is to receive blood. Guide the pupils in filling in their worksheets.

4. One at a time have the pupils push one of their fingers through the auricle of the beef heart. Have a pupil do the same on the model and show where his finger ends up.

5. Make a second latitudinal cross section about one inch from the bottom of the heart and expose the openings. Have a pupil again push his finger through the auricle and point out that this is the same area as before. By pupil investigation point out that this area is larger and more muscular. Tell them that this part is called a ventricle. Ask, what is the job of this section. Develop the idea of pumping blood.

6. Have the pupils recall that blood vessels take blood to and from the heart then ask what keeps the blood from moving backward. Elicit that something must be stopping it. Point out that there are structures called valves that open and close tight when blood moves past them. Show, on the model and their diagram,the location of the valves.

7. Ask the pupils why they think the heart is divided into two halves. Lead them to discover that the right side of the heart receives oxygen-poor blood and pumps blood to the lungs, the left side pumps oxygenated blood to the entire body.

SUMMARY:

Review the names of the sections of the heart and have the pupils describe the differences between the auricle and the ventricle. Review the function of valves in the body and if time permits ask the pupils if they have ever seen people with veins bulging on their legs. Point out that this happens when a valve stops working. Ask the pupils why they think blood must be pumped to the lungs. (This concept will be developed fully in future lessons.)

HOMEWORK:

1. If you had to describe the heart in one word which word would you use? Why did you choose this word?

2. Why is your heart divided into two halves?

3. List some differences between an auricle and a ventricle.

4. Why are valves important?

TEACHER NOTE:

For the next lesson obtain sheep or calf's lungs from a butcher.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

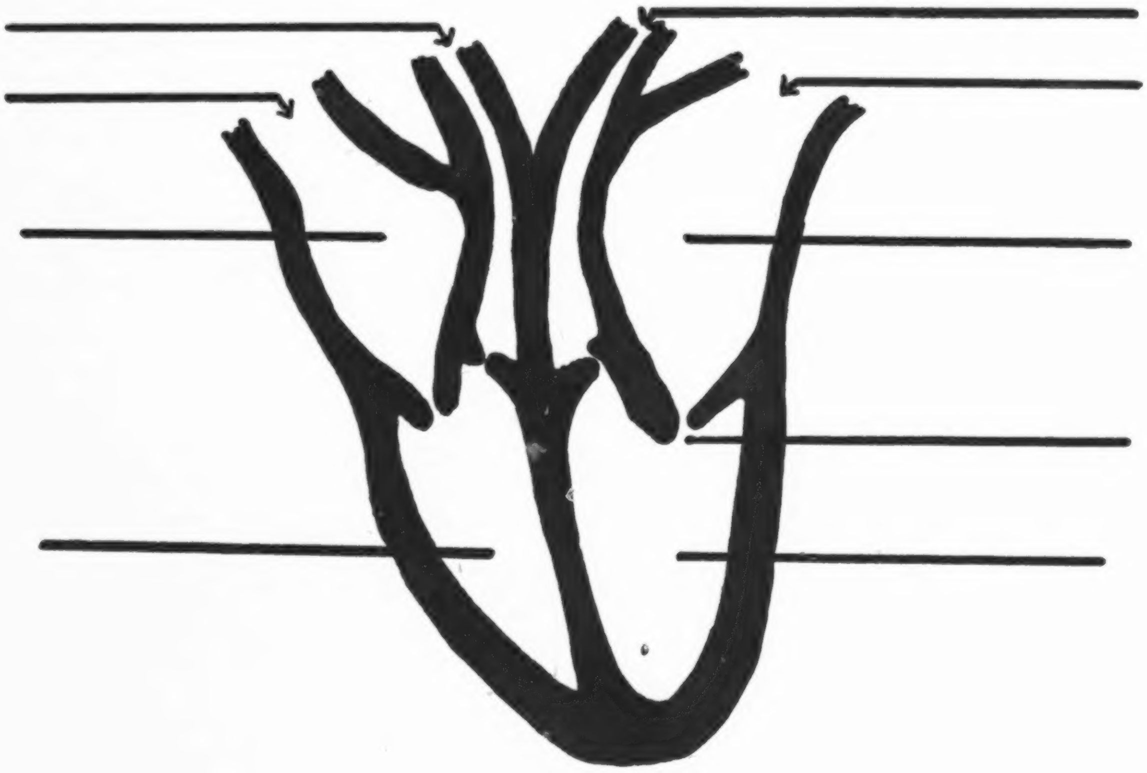
LESSON 13. What does my heart look like?

MATERIALS:

diagram of heart for labeling

PROCEDURE:

As you label the diagram of the heart answer the related questions.



1. Why do you think the heart is divided into two halves?

____

2. The openings in the top part of the heart are called? ____________.

The job of this chamber is to ______________________________.

3. The larger openings in the bottom of the heart are called ________.

The job of this chamber is to ______________________________.

4. How does the blood get from the heart to the body?

____

5. What is the main job of the heart? _______________________

____.

6. Why are values important? ______________________________

____

7. Where does blood go after it leaves the right side of the heart?

____

8. After leaving the left side of the heart blood goes to the

____.

9. The heart has __________________ chambers.

BIOLOGY - HOW OUR BODY WORKS

C. RESPIRATION

LESSON 14 Why is it hard to catch our breath after running a race?

OUTCOMES:

1. We breathe all day and all night long for our entire lives.
2. The human "engine" needs air as well as food for fuel.
3. The heat that keeps you warm is made when the food you eat and the oxygen you breathe join in your body to make energy.
4. Your muscles can only move when you have oxygen. Even your heart would stop beating without oxygen.
5. The more exercise we do the more oxygen we need to keep our body running smoothly.

MATERIALS:

1. Source of water
2. Gallon jar (marked off in pints)
3. Large basin
4. Rubber tube

PROCEDURE:

1. Motivate the lesson by asking, "Why is it hard to catch our breath after running a race?" Having the pupils hold their nostrils, take a deep breath and close their mouths for 10 seconds. "What happens when you release your nose?" "Why do you make a gulping noise?"

2. Ask students to feel each others hands, forehead and neck after exercise. How does the skin temperature feel? What makes them feel warm?

3. Distribute the pupil worksheet. Assist the pupils in reading and understanding the instructions.

SUMMARY:

After they have performed the pupil activity:

1. Guide the pupils to understand that we must breathe all the time. What would happen if we stopped breathing?

2. Conclude that the air we breathe helps keep us warm. Where does this heat come from? Burning food needs oxygen. Heat is produced from burning of food.

3. More oxygen is required when we do exercise because we are using (burning) up our fuel more quickly. How is our breathing changed after we do exercise?

HOMEWORK:

1. Time yourself with the kitchen clock second hand to see how many breaths you take a minute.

2. Hop up and down 20 times and write the number of breaths taken in a minute.

3. Run up and down the steps of your house for a few minutes and then test your breathing rate for a minute.

4. Compare the number of breaths you take after doing different exercises with the number taken when standing still?

5. Why do you take more breaths?

REFERENCES:

1. New York State General Science Handbook Pages 1130 - 1132

2. Investigating Science 8 - Singer Laboratory Excercises Page 55

PUPIL WORKSHEET

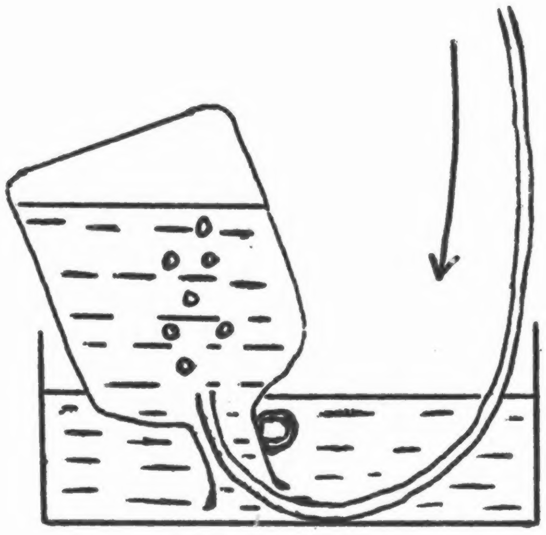
LESSON 14 : How does exercise affect our breathing rate?

MATERIALS:

Gallon jar (marked off in pints), large basin, rubber tube, water

PROCEDURE:

1. Diagram



2. Fill a gallon jar with water.

3. Hold your hand over the mouth of jar and place upside down in a half filled basin of water.

4. Put one end of rubber tube into the gallon jar of water.

5. Blow into the rubber tube so that air enters the gallon jar. How do you know air has entered the jar? Measure how much air you have by seeing how far down the water level went.

6. Refill the gallon jar. Do 10 deep knee bends and blow into the tube of the jar. Measure how much air you have by seeing how far down the water level went.

QUESTIONS:

1. When I blew into the jar in step 5 (before exercise) the water went down ———————— pints.

2. This shows that I had ———————— pints of air in my lungs.

3. When I blew into the jar in step 6 (after exercise) the water went down ———————— pints.

4. This showed that I now had ———————— pints of air in my lungs.

5. Exercise makes me breathe ————————————(slower, faster).

6. I need (more, less) ———————— air (oxygen) because my body is burning more food for ————————.

C. RESPIRATION

LESSON 15. Where does air go in our body?

OUTCOMES:

1. Many parts of our body help us breathe ... the nose, windpipe, bronchial tubes, lungs.
2. These parts (organs) work together to carry the oxygen in the air to the lungs.
3. We call these parts the Respiratory (breathing) System.

MATERIALS:

wall chart and manikin
calf or sheep lung
forceps
scalpel
large beaker containing water
dissecting pan

PROCEDURE:

1. Motivate the lesson by showing the pupils the lung dissection. Tell them that they can help cut it apart.
   Note: Calf or sheep lung as mentioned previously may be obtained in a supermarket.

2. Allow the pupils to move closer to the demonstration table.

3. Distribute the pupil worksheet. Read with the pupils the questions that will be answered after the dissection is completed.

4. a) Prepare the calf lungs in the dissecting pan.
   b) Locate the windpipe for the pupils. Allow them to feel and explore this structure.
   c) Cut open the windpipe and feel the inside of the structure.
   d) Cut off a piece of lung and allow pupils to examine its texture and structure. Ask them to compare it to a sponge.
   e) Use a straw to blow air into the lungs. Allow pupils to inflate the lungs with separate straws. What does the body use instead of the straw? Why is "windpipe" a good name for this part?

5. Remove the dissected material and replace it with the torso manikin. Using the manikin, take out and expose the windpipe, bronchial tubes, and lungs. Have the pupils identify these parts and then put them back in the model. Allow a pupil to repeat this procedure naming the different parts.

6. Refer to the wall chart. Allow pupils to point out the parts of the respiratory system beginning with the nose and mouth.

7. Refer to the laboratory sheet previously distributed. Have the pupils label the parts using the chart and manikin as a guide. Re-read the questions with the pupils. Answer several of the questions in class, as time permits.

SUMMARY:

After these activities have been completed, guide the pupils to understand that many organs are part of the Respiratory (breathing) System.

1. What are the parts of the respiratory system?
2. How does our nose help us in breathing?
3. Why does the windpipe feel so hard?
4. Why do we need a windpipe and bronchial tubes?
5. Why do the lungs feel soft?
6. Why must the lungs be so spongy?

HOMEWORK:

1. Complete the diagram of the body by labeling each part.

2. Answer the questions on the worksheet not completed in class.

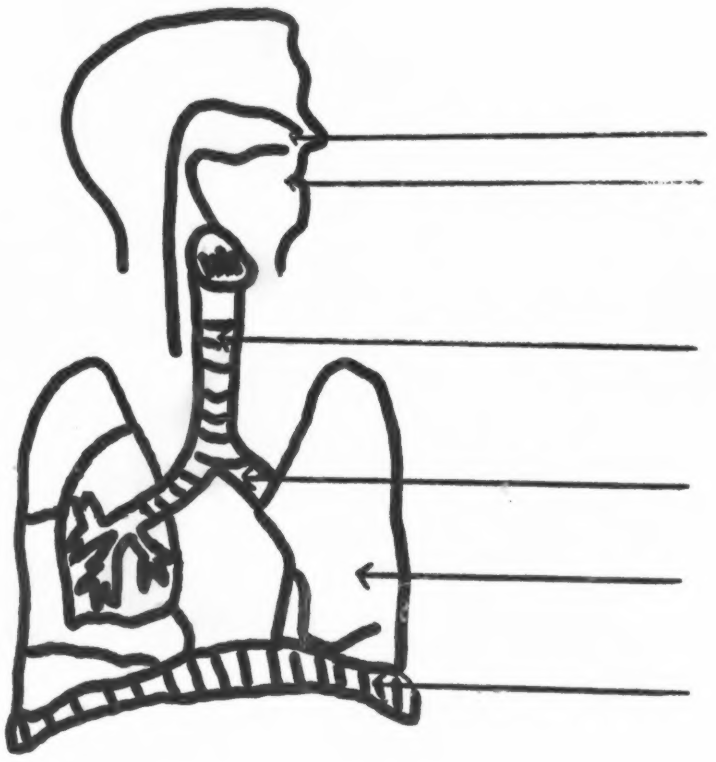
PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 15. Where does the air go in our body?

MATERIALS:

Diagram of human body
Observation questions

Diagram of Respiratory System. Label the parts shown below:



QUESTIONS:

1. Air from the outside first enters our bodies through the ______________.

2. The windpipe carries air from the ___________ to the ________________.

3. The __________ tubes attach the windpipe to the lungs.

4. The lungs hold lots of _______________ which it sends to the rest of the body.

5. The ___________ feels hard and strong. It must be hard to make sure that ________ goes through it to the lungs.

6. The ___________ feel spongy.

7. The lung needs its spongy openings to hold all the ______________.

8. When we blew air into the lungs it became ______________.

HOW OUR BODY WORKS

C. RESPIRATION

LESSON 16. Why does our chest change shape when we breathe?

OUTCOMES:

1. Our lungs are inside a cage made up of the ribs and diaphragm.
2. Our ribs move up and our chests get bigger when we breathe in (inhale).
3. Our chest gets smaller when we breathe out (exhale).
4. When we breathe in (inhale) the diaphragm goes down making more room for air to go into our lungs.
5. When we breathe out (exhale) the diaphragm goes up pushing air out of our lungs.

MATERIALS:

Teacher

4 cardboard strips of equal size
paper fasteners (see diagram)

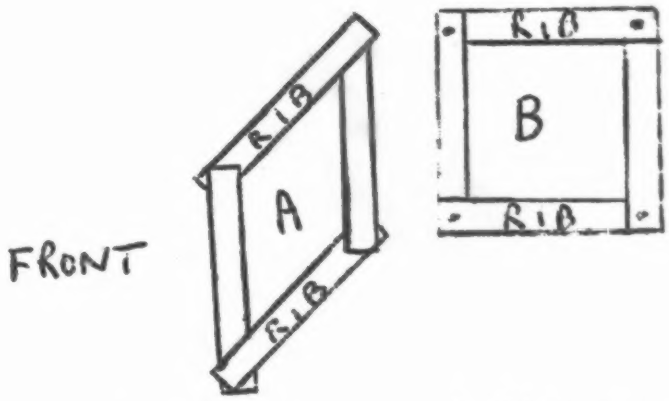
Pupil

quart size malted or coffee cup
scissors
balloon
saran wrap, 6" square
scotch tape
plastic drinking straw
sheet rubber, 5" square
2 rubber bands

PROCEDURE:

1. Motivate the lesson by asking the pupils to take a deep breath and hold it for a few seconds. Call attention to the changes in the size of the chest by having pupils place their hands on their chests to observe the expansion of the chest and the movement of the ribs. If time permits, you may wish to have pupils use a tape measure or a string to measure the expansion of the chest.

2. Attach the cardboard strips with the paper fasteners. Use this model to show the relaxed and raised position of the ribs and chest.



A. BREATHING OUT

B. BREATHING IN ... MORE ROOM FOR AIR IN CHEST CAVITY (LUNGS)

3. Encourage pupils to think through such questions as, "What happens to the lungs when there is more room?" "Does the air move in or out when there is more room caused by the expansion of the chest space?"

4. Display a chart or manikin to locate the diaphragm. Ask, "How does the movement of the diaphragm also help us to breathe?"

5. Distribute the pupil worksheet. Assist the pupils in reading and understanding the instructions.

6. After the pupils have completed their models of the respiratory system, have them explain in their own words how we breathe.

SUMMARY:

1. Relate the parts of the model prepared by the pupils (see worksheet) to the human respiratory system. Compare the parts of the body to the straw, the balloon and the rubber sheet. (Use the bell-jar and lung demonstration).

2. Encourage pupils to explain in their own words how the chest gets bigger (rib and diaphragm movement).

3. Why does the air rush in (inhaling) when the chest gets bigger?

4. Why is air forced out (exhaling) when the chest space gets smaller?

5. Stress the new terms developed in this lesson and guide pupils in using the new vocabulary in explaining how we breathe.

HOMEWORK:

1. Complete laboratory sheet questions at home.

2. What does a lifeguard or policeman do to try to save a person from drowning? Why does breathing into the victim's mouth help?

3. Do you know what an iron lung is? Find out how it can help keep a person alive.

REFERENCES:

The General Science Handbook Part One, New York State p. 45 - 46

5

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

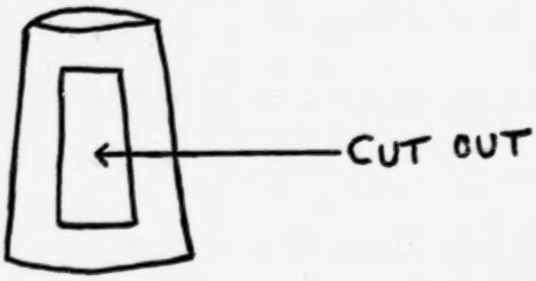
LESSON 16 . Why does our balloon (lung) fill up with air?

MATERIALS:

- quart size cup
- scissors
- balloon
- saran wrap, 6" square
- scotch tape
- plastic drinking straw
- sheet rubber, 5" square
- 2 rubber bands

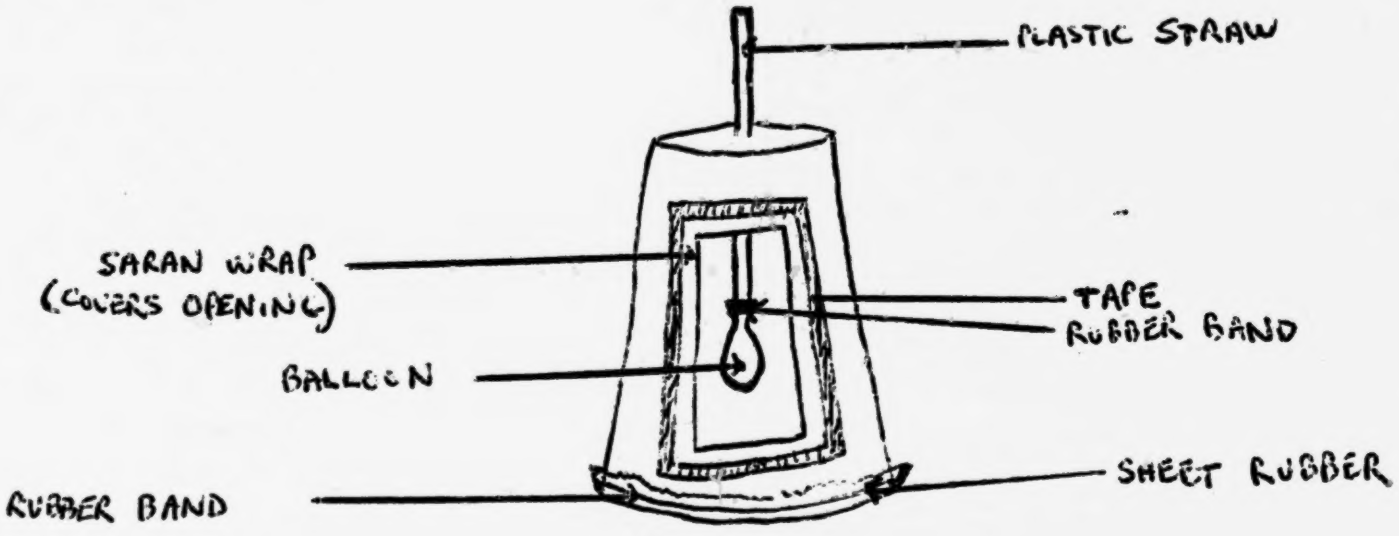
PROCEDURE:

1. Using the scissors, cut out a section of the cup so that it looks like this:



2. Put the piece you cut out on top of the piece of saran wrap. Now cut the saran wrap so that it is a little larger than the paper you cut out on all sides.
3. Put the saran wrap over the opening you cut in the cup. Smooth it out and use the scotch tape to tape it to the cup.
4. Use the scissors to punch a small hole in the center of the bottom of the cup so that the straw will fit into it nice and tight - (do not make a big hole).
5. Blow up the balloon several times. Now put the balloon over one end of the straw (without blowing it up). Tie the balloon to the straw by winding the rubber band around the end of it.
6. Hold the end of the straw with the balloon in your hand and push the other end through the hole in the bottom of the cup. Pull the straw through so that the balloon is inside the cup.
7. Now put the piece of sheet rubber over the top of the cup and fold it around the edges. Stretch the rubber band over the cup and around the sheet rubber to hold it on the cup.

8. Your model of the respiratory (breathing) system should look like this:


PLASTIC STRAW
SARAN WRAP (COVERS OPENING)
TAPE
RUBBER BAND
BALLOON
SHEET RUBBER
RUBBER BAND

9. Hold the model in one hand so that you can see through the saran wrap. Pull the sheet rubber down by pinching it in the center.(Be careful not to pull too hard). Push the sheet rubber up into the cup model. LOOK AT THE BALLOON WHILE YOU DO THESE THINGS.

QUESTIONS:

1. When you pulled the sheet rubber down the balloon ____________________.

2. This happened to the balloon because there was more room for ________ to fill up the inside.

3. When you pushed the sheet rubber up the balloon ____________________.

4. This happened because there was less room and the air was pushed out of the ___________________________.

5. Match the following parts of the model with the parts of our respiratory system that do the same job (lungs, diaphragm, rib cage, windpipe, nose).

   1. open end of straw ______________________
   2. straw ______________________
   3. cup ______________________
   4. balloon ______________________
   5. sheet rubber ______________________

C. RESPIRATION

LESSON 17. How does oxygen get from our lungs to the rest of our body?

OUTCOMES:

1. During respiration we take in oxygen and give off carbon dioxide.
2. Oxygen goes through the lungs into the blood where it it carried to the body cells.
3. Carbon dioxide is produced in the body when we use oxygen to "burn" the food for energy.
4. Carbon dioxide goes into the blood where it is carried through the lungs and exhaled from the body.

MATERIALS:

Teacher

phenolphthalein solution
plastic or cellophane bag
beaker
dilute ammonium hydroxide
chart of heart and respiratory system
torso manikin
test tubes and rack
lime water
plastic straws

PROCEDURE:

1. Motivate the lesson by pouring some water into a plastic bag. Put some colorless phenolphthalein indicator into the water and tie the bag closed. Compare the bag to a body cell. Suspend the bag over a beaker in which there is some ammonium hydroxide solution. (The ammonia molecules will soon diffuse through the plastic, turning the phenolphthalein of the artificial cell pink.)

2. Ask the pupils why they think the "cell" turned pink. Then, ask, "Did the liquid in the beaker get into the cell?" Lead them to realize that the gas was able to"go through" the plastic cell.

3. Conclude that oxygen is a gas that also goes through the lung cells into the blood.

4. Pour limewater into each test tube in the rack. Allow pupils to exhale through straws into the limewater.

5. Guide them to see that we are exhaling a gas that makes the limewater milky. How do we know that oxygen is not making the limewater milky? Explain that the milky appearance of the limewater is caused by the by the presence of carbon dioxide. Conclude that carbon dioxide is also a gas.

6. Display a chart or manikin to trace the arteries and veins to and from the lungs.

7. Explain that oxygen and carbon dioxide are carried by the blood that flows through the arteries and veins.

8. Distribute the pupil worksheet. Assist the pupils in reading and understanding the questions.

SUMMARY:

1. Compare the exchange of gases in the plastic "cell" and the cells that the lungs serve to get the oxygen into the blood so that it can be carried to all the cells of the body. The lungs also serve to remove the carbon dioxide from the blood. The carbon dioxide comes from the oxidation ("burning") of food for energy in the cells.
2. Trace the path of the blood rich in CO_2 from the heart to the lungs by way of the Pulmonary Arteries. Trace the return of the oxygen-rich blood from the lungs to the heart by way of the Pulmonary Veins.

HOMEWORK:

1. Why are the lungs very important?

2. Where does the carbon dioxide come from?

3. Why do we need oxygen?

4. How do we get the oxygen from the lungs and the carbon dioxide to the lungs?

REFERENCE:

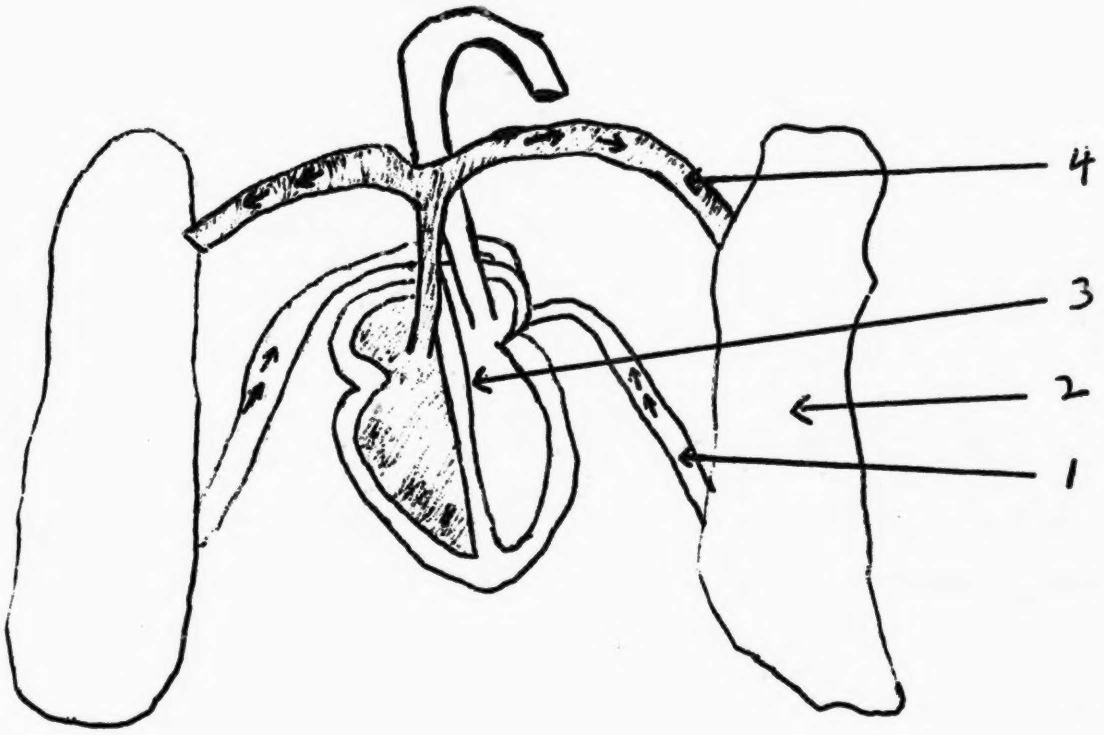
New York State Biology Handbook, Page 15, 1965.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 17 . How does the heart help get the oxygen from the lungs and the carbon dioxide to the lungs?

PROCEDURE:

Shown below is a drawing of the lungs and heart. Following the directions of your teacher, label each of the numbered arrows (#1, #2, #3, #4) in the drawing.



QUESTIONS:

1. The vessels that carry blood from the ________________ to the lungs are shaded.
   They are called the Pulmonary Arteries.

2. The vessels that carry blood from the lungs to the ________________ are not shaded.
   They are called the Pulmonary ________________.

3. Carbon dioxide and oxygen are (gases, liquids, solids) ____________.

4. Oxygen passes from the lungs to the ________________.

5. Carbon dioxide passes from the blood (Pulmonary Arteries) to the

   ______________________.

HOW OUR BODY WORKS

C. RESPIRATION

LESSON 18 How can we make our muscles stronger?

OUTCOMES:

1. We need oxygen to "burn" (oxidize) our food.
2. When our food is oxidized we get energy to move our muscles.
3. Oxidation also produces heat, energy, carbon dioxide, and water.
4. When we exercise, more oxidation takes place for energy. This in turn, makes more heat, carbon dioxide, and water.

MATERIALS:

Teacher

2 candles
2 battery jars
lime water
2 glass plates
plastic drinking straws
1% solution of sodium hydroxide
phenalphthalein

Pupils

small mirrors
half-pint bottle of water to which exactly 5 drops of 1% sodium hydroxide has been added

Note: To make 500 ml. of 1% sodium hydroxide, weigh out 5 grams of sodium hydroxide pellets, on a piece of filter paper. Put them into a graduate cylinder and fill the cylinder with water up to the 500 ml. line.

Caution: Sodium Hydroxide pellets are caustic. DO NOT TOUCH WITH FINGERS.

PROCEDURE:

1. Motivate the lesson by melting the base of a candle over a flame and fastening it to the bottom of a dry battery jar. After lighting the wick and allowing the candle to burn, carefully pour lime water into the battery jar up to an inch in depth. Cover the jar with a glass plate and direct the pupils to observe what happens. Ask the pupils to explain in their own words why they think the candle flame goes out.

2. Shake the battery jar and have the pupils notice that the lime water becomes cloudy. Encourage pupils to relate this result to a previous activity - testing for CO_2. Also lead them to note that the glass plate became warm and that there are drops of moisture on its under side.

3. Elicit that when a candle burns, heat, carbon dioxide, and water are produced.

4. Have several pupils blow on small mirrors and note the results.

5. Have several pupils exhale through a drinking straw into small bottles of fresh lime water and note the results.

6. Have pupils blow against their forearms and note increase in temperature.

7. Guide them to see how we compare with the lighted candle....... Condlude that we also give off heat, carbon dioxide, and water.

8. Explain that both "burning" processes are called OXIDATION.

9. Distribute the pupil worksheet. Assist the pupils in reading the instructions and understanding the questions.

SUMMARY:

Develop the understanding that, in the body, food is the fuel (like the candle). Oxygen, from the lungs, is carried by the blood to the cells. The oxygen combines with the food (oxidation) to give us the energy for moving our muscles.

HOMEWORK:

1. What fuel do we burn to give us energy?

2. What do we call this"burning"?

3. What fuel does a train engine, and a car burn to give them energy?

4. What name do you think we can give to this burning?

5. At what temperature does oxidation usually keep our body?

6. Does oxidation take place in our body all the time? How do you know?

REFERENCES:

1. New York State General Science Handbook #2 Page 115

2. Science Problems 2 , Wilbur Beauchamp- Scott, Foresman and Company Oakland, New Jersey

3. Health For All Gr 7, Bauer et al. Scott, Foresman and Company Oakland, New Jersey

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 18. How do we know that exercising will give us more energy?

MATERIALS:

2 half-pint bottles half filled with water to which your teacher has previously added exactly five drops of sodium hydroxide

phenolphthalein
plastic drinking straws
stop watch or wristwatch with second hand

PROCEDURES:

1. Add phenolphthalein drop by drop into one of the solutions until that solution turns red.

2. Have one pupil write down the exact time to the second that the solution turns red.

3. Another pupil should blow through the straw placed into this solution.

4. Keep this up until the solution becomes colorless and write down the time in seconds. How many seconds did it take for the red solution to become colorless.

5. Your teacher will write the number of seconds for each group on the board..... What did you breathe out that turned it colorless?

   ____.

6. Add drops of the liquid phenolthalein to turn your other bottle's solution red.

7. Change places and allow another pupil to keep the time .

8. Exercise by touching the floor 15 times very quickly.

9. Now breathe into the bottle through the straw.

10. How many seconds did it take for the solution to turn colorless again?

11. Compare your time for the first bottle (without exercise) to turn colorless and the second bottle (with exercise).

12. Why do you suppose there was a difference in how quickly each bottle became colorless?

QUESTIONS:

1. How many seconds did it take for the first bottle (without exercise) to turn colorless? ______________________

2. How many seconds did it take the second bottle (with exercise) to turn colorless? ________________

3. After exercise the second bottle turned colorless (quicker, slower)

____________.

4. The gas we breathed into the bottles to make them colorless was

__________ ____________.

5. Exercise caused us to use more energy and breathe out more

__________ ____________.

6. Exercise causes our bodies to (speed up, slow down) ________ the oxidation of food for energy.

HOW OUR BODY WORKS

D. EXCRETION

LESSON 19. How is the inside of our body kept clean?

OUTCOMES:

1. Wastes are the products of oxidation of foods for energy.
2. If these wastes were not removed from the body, they would poison us.
3. Carbon dioxide and water vapor are removed by the lungs (gaseous wastes).
4. Liquid wastes, water (and urea) are removed by the skin (pores) and kidneys.
5. Solids wastes are removed by the large intestine.
6. The way in which your body gets rid of wastes is called excretion.

MATERIALS:

Teacher

model of kidney
model of skin
model of torso

Pupil

worksheet diagram of excretory organs

PROCEDURE:

1. Motivate the lesson by asking, "What would happen if you could not dispose of your left-over foods?" (wastes)

2. Lead the pupils into a discussion of what would happen if we could not get rid of our wastes.

3. Recall from the previous lesson that we form carbon dioxide and water vapor (from oxidation). Ask, "How do we get rid of these wastes?"

4. Tell the pupils that hard parts of vegetables and fruits cannot be digested and become solid waste. This solid waste goes through the large intestine and out the rectum. Identify the parts on the torso model.

5. Guide the pupils to discuss how we get rid of liquid wastes. Liquid waste (water and urea) is removed by the kidney and skin.

6. Distribute the pupil worksheets and help them read and understand the instructions. The worksheet describes a simple exercise in having pupils identify the organs of excretion. Using the various models and torso will lend added realism to the pupils' ability to visualize the location and function of these organs.

SUMMARY:

1. Define wastes as "left-overs" or products of oxidation when the body uses food and oxygen.
2. Define excretion as the way in which we get rid of wastes.
3. Review the use of the terms solid, liquid, and gas.
4. Review the parts of the excretory system.
5. Stress the effect on the body if wastes were not removed.

HOMEWORK:

1. Complete the pupil worksheet.
2. Give the meaning of the words waste, excretion, solid, liquid, and gas.
3. What would happen to us if we did not remove our body wastes?

REFERENCES:

Investigating Science 8, Kahn et.al., Singer Company, 1966.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 19. What parts of our body help get rid of wastes?

MATERIALS:

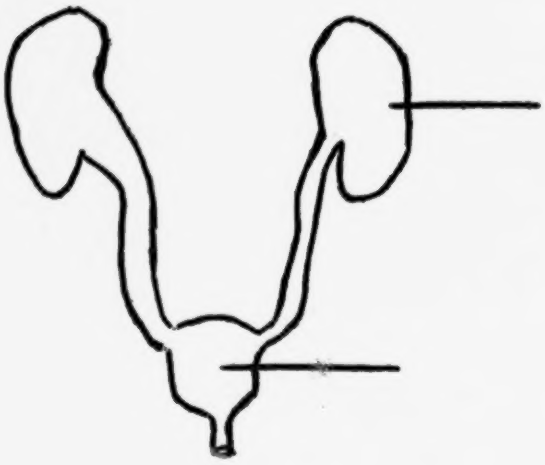
diagrams of the human body showing the organs of excretion
tracing paper
scissors

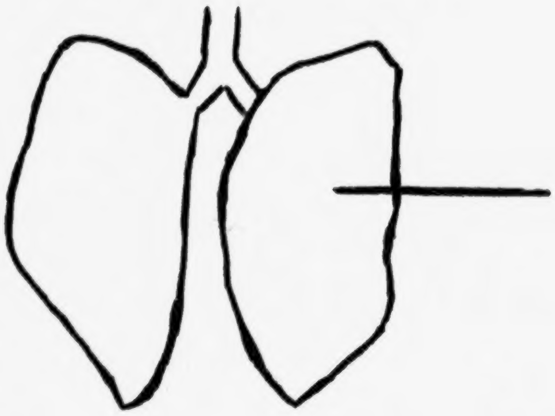
PROCEDURE:

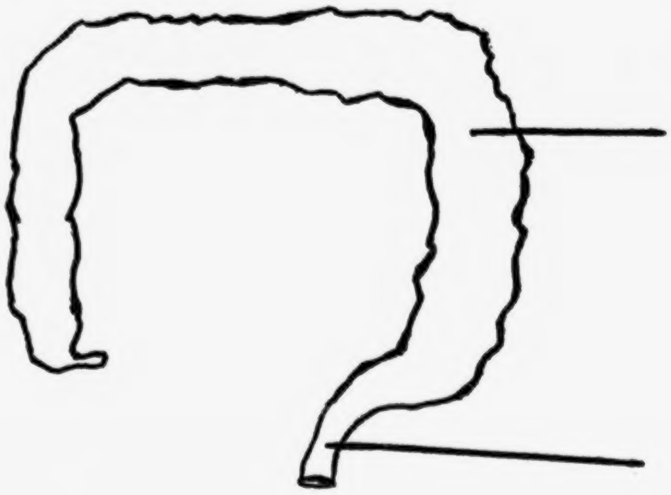
1. Look at the model of the human body on the teacher's demonstration desk. See if you can find the parts listed below. Label the parts on your diagrams.

Diagrams of Human Body

lungs
bladder
large intestine
rectum
kidney







2. Trace the body parts shown on the worksheet.

3. Cut out each part and arrange them in the right order.

Answer the questions below.

1. We get rid of carbon dioxide wastes through the ________________.
2. Solid wastes are eliminated (removed) by way of the ______________ and the ____________________.
3. Liquid wastes are removed through the __________________ and ____________________.
4. Water vapor is removed through the __________________.
5. Salt wastes are removed by means of the ____________________.

D. EXCRETION

LESSON 20, Why do we sweat?

OUTCOMES:

1. Sweat is made up of body wastes - water, salt, and urea.
2. Sweat is removed by our skin through the pores.
3. Body heat helps the water evaporate from the body.
4. Our skin becomes cooler when water (sweat) evaporates.
5. The salt and urea wastes must be washed off the skin.

MATERIALS:

Teacher

cross section chart of skin layers
several hand magnifying glasses

Pupil

dropping bottles of water and alcohol
large chemical thermometer
cotton wad

PROCEDURE:

1. Motivate the lesson by having pupils observe the skin on their hands and arms with the magnifying glasses. Ask them to note the small openings. Explain that these openings on the skin are called pores.

2. Exhibit a cross section chart of the outer and inner layers of the skin. Show the path the sweat takes from the blood capillaries through the passageway (duct), the pore (opening), and out to the skin.

3. Explain that sweat contains several body wastes - water, salt, and urea. (Point out the similarity to the word urine.)

4. Ask pupils to describe how their sweat (perspiration) tastes after doing heavy exercise. Guide them to realize that this salty taste is caused by the waste products, salt and urea.

5. Ask the question, "How can we remove this salt and urea from the skin?" Then, lead the pupils to an understanding of the necessity for washing frequently.

6. Distribute the pupil worksheets. Explain that we will try to find what happens to the liquid waste on the skin. Assist the pupils in reading and understanding the instructions and questions.

SUMMARY:

1. Develop the understanding that evaporation of water (sweat) from the skin results in cooling.
2. Guide the pupils to realize that body heat causes water to evaporate faster. This evaporation uses up heat resulting in cooling.
3. Review the function of the sweat gland and pores in removing body wastes.
4. Refer to the model and chart of the skin. Indicate the sweat gland, duct and pores.

HOMEWORK:

1. Why do you think the skin is important in keeping our body at a steady temperature?

2. Why do you think it is necessary to wash daily and take baths frequently?

3. Why is it necessary to drink a lot of water every day ?

REFERENCE:

Kahn, et. al., Investigating Science 8, L.W. Singer Co., 1966

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 20. Why is it good to perspire?

MATERIALS:

dropping bottles of water and alcohol
large chemical thermometer
cotton wad

PROCEDURE:

1. Have your partner put a few drops of alcohol on one of your hands and a few drops of water on the other hand.
2. Change positions and put a few drops on your partner's hands.
3. Which hand dried first? ____________________
4. Which hand felt cooler? ____________________
5. Why do you think that your hands felt cooler? ______________
6. Why do you think that one hand felt cooler faster? __________
7. When you have finished ask the teacher to help you read the temperature of a thermometer.
8. Write down the temperature. ________________
9. Now wrap cotton around the bulb of the thermometer and wet with water. Fan the thermometer for several minutes. What is the temperature now? ______________
10. Why do you think the temperature is lower? ________________

QUESTIONS:

1. To evaporate water means to (add more water, dry up water) _____.
2. What is left on our skin after the water vapor evaporates?

   ____

3. Why must we wash our skin more often in the summer time?

   ____

4. Why do we feel cool after we have been sweating?

   ____

5. Why does a fan make us feel cooler?

____

6. Why is it good to perspire?

____

HOW OUR BODY WORKS

D. EXCRETION

LESSON 21 Why isn't a fighter allowed to throw a kidney punch?

OUTCOMES:

1. The kidney removes body wastes from the blood.
2. These wastes, called urine, pass through tubes from the kidney to the bladder.
3. Water and other useful substances (food nutrients) are absorbed from these tubes back into the blood.

MATERIALS:

Teacher

plastic model of kidney parts

Pupil

red chalk (powdered)
(5% solution) tincture of merthiolate
funnel
filter paper
beaker
stirring rod

PROCEDURE:

1. Motivate the lesson by discussing the danger of a kidney punch. Why can a fighter be seriously injured if he gets a blow to his kidneys?

2. Develop an understanding of the importance of our kidneys.

3. Exhibit the plastic kidney model.

4. Allow the pupils to gather around the demonstration table and examine the model of the kidney.

5. Ask pupils to describe its color and shape.

6. Find the tube that leaves the kidney. Find the artery and vein that feed the kidney .

7. Take the kidney apart to show the collecting tubules and urinary tube connections.

8. Explain to the class:

   a. The blood carries body wastes through the capillaries into these tubules in the kidney.

   b. The kidney has tubes which carry these wastes (urine) to the bladder.
   c. Water and other useful substances are absorbed back into the blood.

9. Distribute the pupil worksheets. Assist the pupils in reading the instructions and questions.

SUMMARY:

1. Based on the teacher demonstration and the laboratory activity, guide the pupils to understand the vital function of the kidneys in keeping our bodies healthy. What would happen if our kidneys did not work?
2. Review the parts of the excretory system (kidney, urinary tubes, bladder). Refer to charts and model.

HOMEWORK:

1. What are the names of the body wastes that we have learned about?

2. From what part of the body can each of the following wastes be excreted?

   a. solids
   b. salt
   c. urine
   d. water vapor
   e. carbon dioxide

   Select the correct words below to answer this question:

   lungs, nose, rectum, kidney, skin pores, mouth, bladder, and large intestine

3. Complete the lab exercise questions.

REFERENCE:

Biology Handbook , New York State, 1960 Page 211

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 21. How is urine collected?

MATERIALS:

powdered red chalk
tincture of merthiolate (5% solution)
funnel
filter paper
2 beakers
stirring rod

PROCEDURE:

1. Fold the filter paper as your teacher will show you. Place the paper in the funnel.

2. Add the powdered chalk to a beaker half filled with water.

3. Put a few drops of the merthiolate in the water.

4. Stir the mixture with the rod.

5. Add more drops of merthiolate, if necessary, so that you get a yellowish color.

6. Place the clean empty beaker under the tube as your partner pours the liquid into the funnel.

QUESTIONS:

1. What passed through the filter paper into the clean beaker?

2. What material was stopped by the filter paper?

3. What is the name of the waste that our kidney collects in the tubes?

4. What does the yellow liquid that goes through our tube into the clean beaker remind us of?

5. What does the red chalk in the filter remind us of in the body?

6. In what way is the kidney like the filter paper in our experiment?

E. BEHAVIOR

LESSON 22 . Can you taste with your nose?

OUTCOMES:

1. We have 5 senses to tell us what is going on around us.
2. The body senses are taste, touch, sight, hearing, and smelling.
3. Food "tastes" are the result of a combination of taste and smell.
4. Our senses help us react to our surroundings.
5. Our senses make us behave in certain ways.

MATERIALS:

Teacher

several blindfolds
pear, apple, potato

Pupil

small packets of sugar
lemon slices or dry instant coffee
milk container with cooked cold spaghetti
dilute solution of perfumed liquid - labeled A
very dilute solution of ammonia - labeled B (5 ml. of ammonia to 95ml. of water)

PROCEDURE:

1. Motivate the lesson by selecting a volunteer to be blindfolded.

2. Have the volunteer hold his nose tightly. Give him a small piece of potato to eat and then apple... Note his difficulty in distinguishing between the two.

3. Ask the class why they think he is not sure as to what he has eaten.

4. Select another volunteer to be blindfolded. He is not to hold his nose. Have him eat a small piece of apple but hold a piece of pear under his nose... Why do you think he believes he has eaten a pear?

5. You may then reverse the procedure for the pear and apple or use 2 pieces of pear and 2 pieces of apple.

6. Guide the pupils to see that both taste and smell are needed in order to identify foods. Would touch or sight have helped us to identify the fruit?

7. Distribute the pupil worksheet and materials. Assist them in reading the instructions and questions.

SUMMARY:

1. Review the 5 senses giving examples of how each is used.
2. Guide the pupils to
    a. understand that our senses cause us to react to our surroundings (refer to stimuli used in the experiment)
    b. understand that we may react in different ways to different surroundings (stimuli)
    c. understand that our senses help to determine our behavior
    d. understand that all our 5 senses are necessary

HOMEWORK:

1. Complete the answers to the questions on the worksheet.

2. Watch the members of your family and friends to see how they react to different sounds, colors or lights, smells, food tastes.

3. Make a chart and write down how they react to the same things.

REFERENCES:

1. New York State Biology Handbook, 1960.

2. General Science Handbook, New York State, 1956. Part 1, Part 3.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 22. What are our five senses?

MATERIALS:

small packets of sugar
lemon slices or dry instant coffee
closed milk container with cooked cold spaghetti
dilute solution of perfumed liquid - labeled A
VERY dilute (5 ml. of ammonia to 95 ml. of water) solution of ammonia labeled B

PROCEDURE:

1. Blindfold one pupil in your group.

2. Have blindfolded pupil stick out his tongue. Squeeze lemon juice (or sprinkle the coffee) on his tongue.

   a. What did he do?
   b. What was his reaction ?

3. Ask him to put out his tongue again. Sprinkle a few grains of sugar on his tongue.

   a. How did he act?
   b. What difference did you notice in his reaction?

4. Open the milk container and let the blindfolded pupil feel the spaghetti with one finger.

   a. How did he act?
   b. What did he think was in the box?

5. Bang a book down on the desk or floor.

   a. How did he react?

6. Call the teacher over to help you with the bottle "A" and the bottle "B".

   a. Have the pupil smell bottle "A". How did he react?
   b. Have the pupil smell bottle "B". How did he react?
   c. What difference in reactions did you notice? Why?

QUESTIONS:

1. Why do you think the blindfolded pupil acted the way he did when he did the following?

   a. tasted the lemon juice (or coffee)
   b. tasted the sugar

c. put his finger in the spaghetti
d. jumped when the book was dropped
e. smelled the perfumed liquid ("A")
f. smelled the sharp liquid (ammonia) ("B")

2. What sense did we use with the lemon juice and sugar?

3. What sense did we use with the spaghetti?

4. What sense was used when the book dropped?

5. What sense was used with bottle "A" and bottle "B"?

6. What sense didn't we use in the experiment?

E. BEHAVIOR

LESSON 23 Why does our mouth water?

OUTCOMES:

1. The body reacts to some surrounding conditions by reflex actions.
2. Reflex actions are automatic. We do not have to think about them.
3. Reflex actions cannot be controlled and are not learned.
4. Reflex actions can protect us from being injured.

MATERIALS:

mirror
feather
clear plastic sheet (approximately 10"x14")
scrap paper

PROCEDURE:

1. Motivate the lesson by exhibiting a large picture of some favorite food. Describe how delicious it tastes.

2. Ask the pupils what happened in their mouths.

   a. Why does our mouth"water"?
   b. Did we tell our mouth to water?
   c. Were we able to control the mouth watering?

3. Explain that we call this automatic behavior a reflex action.

4. Can you think of any other reflex actions? Let's see if we can do some experiments to help us discover other reflex actions.

5. Distribute the pupil worksheet. Assist the pupils in reading the instructions and questions.

SUMMARY:

1. Have the pupils describe in their own words what a reflex action is. Stress that it is involuntary and does not require conscious thought.

2. Review the reflex actions learned about in this lesson.

HOMEWORK:

1. Complete the worksheet at home if not finished.

2. Find out if your pet at home behaves the same way we did in our experiments. Why?

3. Why do some reflex actions help protect our body? Can you name some?

4. Can you think of any other reflex actions we didn't mention?

REFERENCE:

Biology Handbook, New York State, 1960. #4106

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 23. What reflex actions does our body have?

MATERIALS:

mirror
feather
clear plastic sheet (approximately 10"x14")
scrap paper

PROCEDURE:

1. Have one pupil in your group close his eyes for about 2 minutes with his hand over them. After this time let him look at his mirror or at another pupil in the group. What happened to the dark circle in the middle of the eye? (the "Pupil")

2. Have one pupil sit with crossed legs so that one hangs freely. Strike his leg just below the knee with the side of your hand. What happened to the leg?

3. Use the feather or a hair to tickle the inside of the nose. What happened?

4. Have one member of your group remove his shoe. Draw your thumb nail quickly forward along the bottom of the foot. What happened to the toes?

5. Have one member hold a piece of clear plastic close in front of his face. Throw a crumpled up piece of paper towards him. What does he do with his eyes?

QUESTIONS:

1. In the first experiment, when the person opened his eyes, why did the pupil become smaller? ... What did the light have to do with making the pupil smaller?

   a. Did the person think about making his pupil smaller?
   b. What is a reflex action?

2. Name the other reflex actions that we found out about in our experiment.

3. Did we have to think before acting the way we did?

4. a. When we touch a hot object what do we do?
   b. Why is this a reflex action?
   c. How can this reflex action prevent us from being burned?

E. BEHAVIOR

LESSON 24. How does our body know what is happening to it?

OUTCOMES:

1. The skin has sensitive areas (receptors) which receive messages from around it.
2. Some sensitive areas of the skin have more receptors than other areas.
3. If an area of the skin has more receptors it is more sensitive.
4. These sensitive areas (receptors) "tell" our body to react to what is going on around it.

MATERIALS:

Teacher

blindfold
geometric blocks (math kit) or common shapes (marbles, rocks, ruler, chalk, small containers, ink eraser)

Pupil

index cards (3 x 5)
blindfold

PROCEDURE:

1. Motivate the lesson by selecting a volunteer to be blindfolded.

2. Ask this pupil to identify various shapes and objects such as those suggested.

3. Have the class observe how he handles the various objects..... Ask, "What part of his hands did he feel with? Why do you think he used those parts of his hand?"

4. Lead the pupils to understand that some parts of the hand and fingers are more sensitive than others...have more receptors. Guide pupils to become more familiar with the new terms by writing them on the chalkboard and identifying the parts that are familiar to them, i.e., receptor (receive) etc.

5. Do you think that other parts of the body have receptors? Let's see if we can do an experiment to help us discover where there are other receptors.

6. Distribute the pupil worksheets. Assist the pupils in reading the instructions and questions.

SUMMARY:

1. Guide the pupils to see that some distances between feeling two points were greater than others. Conclude that the farther apart the receptors are the less the sensitivity. The closer the receptors are the greater the sensitivity (such as the finger tips).
2. Realize that some people are more sensitive than others.
3. Explain that receptors receive other messages (stimuli) other than touch such as, heat, cold.

HOMEWORK:

1. Complete the worksheet if not finished.

2. Explain why certain areas of the body must be more sensitive than others.

REFERENCE:

Science Grade 8, Long Form

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 24. How sensitive is our arm?

MATERIALS:

two index cards (3 x 5)
blindfold

PROCEDURE:

1. Take one of your cards and fold it in half.

2. Blindfold your partner and have him roll up his sleeve above his elbow.

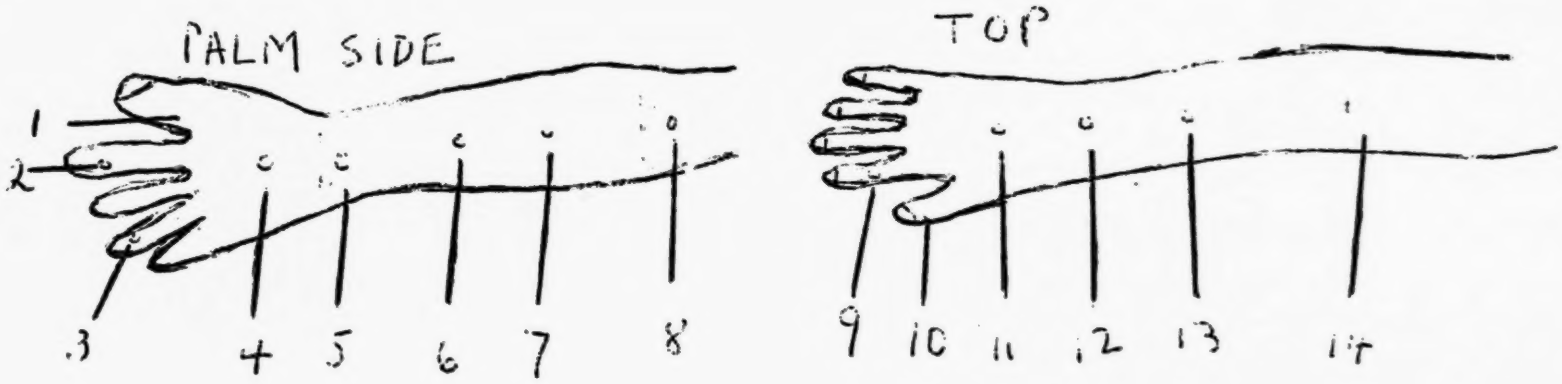
3. Hold the folded card and touch your partner's arm with two sharp corners of the card.

4. Touch his arm with the two points very close together. Ask him if he feels one point or two.

5. When he only feels one point touch his arm again with the points a little farther apart. Repeat this until he feels two points.

6. Do this experiment again on different parts of the hand and arm as shown in the picture. Again start with the points of the card very close so that it feels like one point and then separate them until your partner feels two points.

7. Exchange partners and blindfolds and do the experiment again.



QUESTIONS:

1. Why do you think that sometimes only one point was felt?
2. Where were the distances between sensitivity points (feeling one and two points) the smallest? largest?
3. What do you think these distances between points mean?
4. Why do you think that the distance between feeling one point and two points was not the same for each partner?
5. Why did the pupil who was blindfolded in front of the room use his fingertips to feel the objects?

E. BEHAVIOR

LESSON 25 How can I break a bad habit?

OUTCOMES:

1. Habits are things we learn to do without thinking.
2. Habits are formed by repeating the same procedures over and over.
3. Habits can be helpful because they allow us to do things faster and with more accuracy.
4. Habits can be changed by practicing a new way to do the same thing.

MATERIALS:

Pencil and paper

PROCEDURE:

1. Motivate the lesson by distributing several sheets of paper.

2. Instruct the pupils to write the following paragraph without dotting the "i's" or crossing the "t's". Write rapidly. If pupils find the words difficult to write, you may wish to substitute other easier words.

   "The Indians built their tents of skin. Indians often trapped rabbits. They kept little kittens as pets. Traders tried to give them mirrors and shiny things."

3. Have the pupils check their papers to see how many "t's" were crossed and "i's" dotted.

4. Guide them to see that a habit becomes difficult to change after long practice.

5. Have the pupils turn over their paper to the blank side. Instruct them to tap with their pencils on the paper on the order "tap". After giving the order several times, begin to tap with a ruler while giving the "tap" command. After about 25 repetitions stop giving the command and just tap with the ruler. Continue this ruler tapping as long as most pupils continue to tap with their pencils.

6. Guide the pupils to discuss why they continued to tap after the command ceased.
   "Did we form a new habit?"

7. "Let's see is we can make some habits" so we can find out how they work.

8. Distribute the pupil worksheet. Assist the pupils in reading the instructions and questions.

SUMMARY:

1. Guide the pupils to see how habits can be learned by constant practice and repetition.
2. Once we learn a habit thoroughly we practice it quickly without having to do much thinking about it.
3. New habits can be learned and bad habits changed by practicing until we can do the new habit more easily.

HOMEWORK:

1. Complete the worksheet at home if not finished.
2. List some of the habits we do without really thinking.
3. Why is it helpful to be able to make many of the things we do every day into habits?
4. Can you list some bad habits that you would like to change?
5. Practice writing your name with your "other" hand. Does it become easier?

REFERENCE:

N. Y. State Biology, 1960 pages 227-230.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR EACH PUPIL)

LESSON 25. How can I make a new habit?

MATERIALS:

paper, pencil

PROCEDURE:

1. Write your name as many times as you can in a minute with the hand you usually use.
2. Write your name with the hand you don't usually use over and over again for a minute.
3. Now write your name again ten times with the hand you don't usually use.

QUESTIONS:

1. Why can you write your name more quickly and more easily with the hand you usually use?
2. Why can you write more quickly with the "other" hand after you try to write with it over and over?

PROCEDURE:

1. Rub your stomach in a circle and pat the top of your head at the same time.
2. Practice doing this over and over for a few minutes.

QUESTION:

Why does it become easier to do this after repeating the tapping and rubbing?

E. BEHAVIOR

LESSON 26 . Why are puzzles hard to put together?

OUTCOMES:

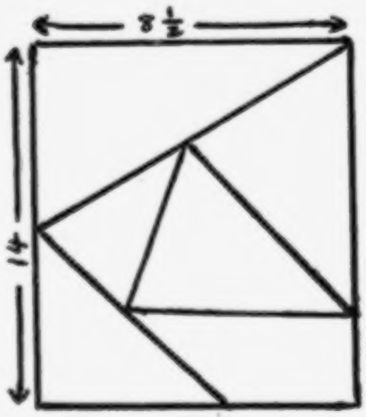
1. We can learn by trying different ways of solving problems.
2. Learning by trial and error (trying different ways) takes a long time.
3. We use the trial and error method to learn when we don't know a better way.
4. When something has meaning we learn it faster.
5. We learn our school work by studying and not by trial and error.

MATERIALS:

envelopes
oaktag puzzle parts (8½" x 14")
large "rat maze" chart
rexographed copies of rat mazes
watch with second hand

PROCEDURE:

1. Motivate the lesson by distributing to each pupil, an envelope containing six puzzle parts as follows:



2. At your signal ask each pupil to arrange the pieces so as to form a rectangle (hold up an 8½x14 piece of oak tag to serve as a model).

3. Tell the pupils to scramble up their puzzle again when they have successfully put them together.

4. Have pupils repeat the procedure, assembling and scrambling the puzzle several times.

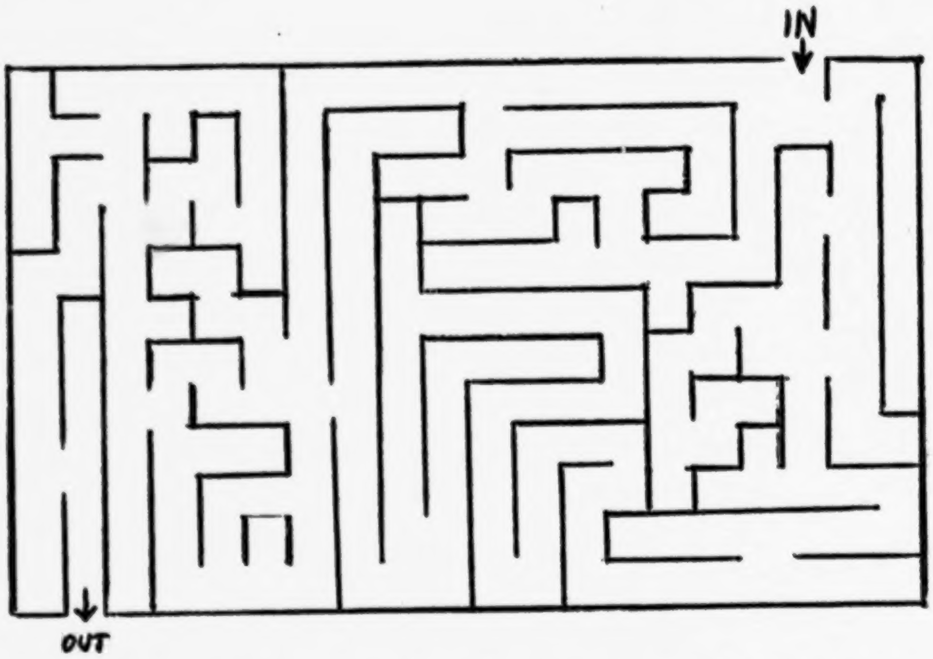
5. Ask, "Why did you have trouble putting the puzzle together?" "Why were you able to do it faster after several tries?"

6. Explain that we call this type of learning "trial and error".

7. Ask a pupil volunteer to explain a good way of putting the puzzle together quickly.

8. Conclude that if the puzzle (what is to be learned) has meaning we can do it faster.

9. Attach the large "rat maze" chart to the blackboard. Explain that scientists place rats in mazes of this type to find out how quickly they learn.



10. Call several volunteers to the chart. Have them use a pointer or ruler to trace the solution. Use the watch second hand to record the length of time taken to solve the maze.

11. Give the pupils a second chance at the maze and note how long they take.

12. Why was it hard to solve the maze? Why were many pupils able to solve it more quickly after several trials?

SUMMARY:

1. Guide the pupils to understand why trial and error is a slow way of learning.
2. Trial and error puzzle solving becomes quicker when we eliminate the errors.
3. In our school work we can learn by studying the correct way. For example, we can solve math problems more quickly by following instructions.

HOMEWORK:

Distribute rexographed copies of rat mazes for pupils to solve at home. Have them repeat their solutions several times noting the time elapsed for each trial.

1. Why were you able to solve the maze more quickly after several trials.

2. Why couldn't you speed up your time after reaching a certain point?

3. Can you write instructions to help others solve the maze quickly?

REFERENCE:

New York State General Science Handbook, Part 3 page 42

E. BEHAVIOR

LESSON 27. How may our senses fool us?

OUTCOMES:

1. The way we react to our surroundings depends on what our senses tell us.
2. Our senses can fool us so that we think we see or feel certain things.

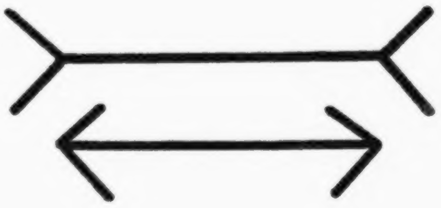
MATERIALS:

Teacher

3 pans of water - 1 ice cold, 1 tepid, 1 very warm

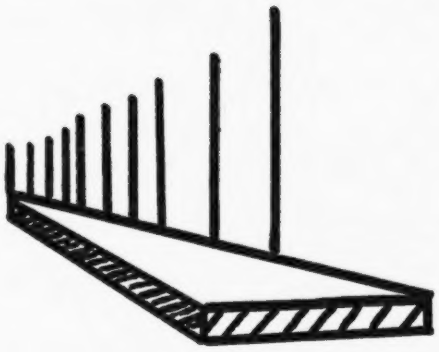
Pupil

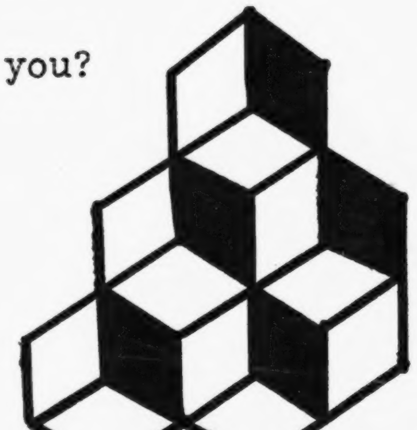
3 x 5 index card
1 black, 1 red crayon
pencil with eraser
knife
ruler
scissors
rexograph sheet of illusions as below: (may be reproduced for homework)



Which line is longer?

Which line is farthest from you?





How many cubes are ther

PROCEDURE:

1. Motivate the lesson by blindfolding two pupil volunteers and asking them to wait outside the door.

2. Exhibit the three pans of water to the class explaining that one is ice cold, another tepid, and the third very warm.

3. Now guide one of the blindfolded pupils to put his right hand into the cold water and then into the tepid. Guide the other blindfolded pupil to put his right hand into the very warm water and then into the tepid water.

4. Ask each pupil how the water in the second pan felt. Discuss why one said the water was warm and the other said it was cool. "Why did their senses tell them different things?"

5. "Let's see if our senses can fool us in other ways."

6. Distribute the pupil worksheets. Assist the class in reading the instructions and questions.

SUMMARY:

1. Guide the pupils to understand that our senses can fool us in many ways.
2. Our senses can make us feel or see things that are not really so.

HOMEWORK:

1. Complete the worksheet at home if not finished.

2. Distribute the rexographed sheet of illusions to be answered at home.

3. How do you know your senses are fooling you?

REFERENCES:

1. New York City, General Science Handbook, pages 28, 29

2. New York State, Biology Handbook, page 215

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

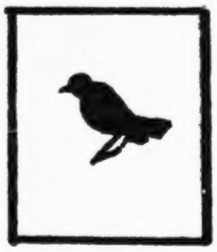
LESSON 27. Can you put the bird in the cage?

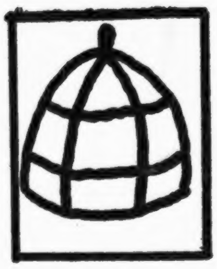
MATERIALS:

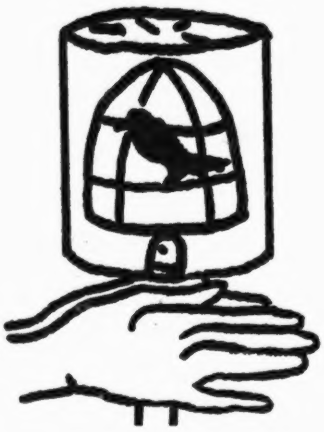
3 x 5 index card
1 black, 1 red crayon
pencil with eraser
knife
ruler
scissors

PROCEDURE:

1. Cut two inches off the end of the card so that it becomes a square.
2. On one side fraw a bird cage and color it black.
3. On the side draw a bird and color it red.
4. Slit the eraser of the pencil with the knife and place the card in the slit.







5. Hold the pencil between the palms of your hand and rotate (turn) it slowly and then faster. Look at the card while you do this.

QUESTIONS:

1. What seemed to happen to the picture on the card as you rotated the pencil faster and faster?
2. Why do you think you saw the bird in the cage?
3. Can you explain how our senses fooled us?
4. In what way does a movie picture fool your senses like the bird in the cage?

E. BEHAVIOR

LESSON 28. Can we see and hear with our brain?

OUTCOMES:

1. The brain controls everything we do.
2. The three parts of the brain are the cerebrum, cerebellum, and medulla.
3. The cerebrum is our "thinker" and controls our senses.
   The cerebellum is our "mover" controlling our muscles.
   The medulla controls our heart beating, breathing, etc.
4. The spinal cord extends downward from the medulla. It carries messages to the brain and back to the body.

MATERIALS:

chart of nervous system
model of the human brain

PROCEDURE:

1. Motivate the lesson by asking the pupils to imagine they are walking along and hear a car stop suddenly behind them.

2. List all the things that you do when you hear the noise.

3. Guide the pupils to understand that their brain makes them hear the sound, stop walking, turn around, watch the car. The brain also enables them to know that a car stopped suddenly.

4. Use the model of the brain and spinal cord to explain the functions of the cerebrum, cerebellum, and medulla.

5. Distribute the pupil worksheet of the brain and its functions.

SUMMARY:

1. Guide the pupils to realize how important the brain is for even very simple actions such as reacting to a loud noise or scratching a foot.
2. Develop an appreciation that all parts must work properly for us to function normally.
3. Evaluate the lesson by determining whether the pupils can recall several vital functions of the brain.

HOMEWORK:

1. Complete the worksheet questions if not finished.

2. Why is the brain a very important organ of the body?

3. Do you think a cat has a brain? A worm? Why?

REFERENCE:

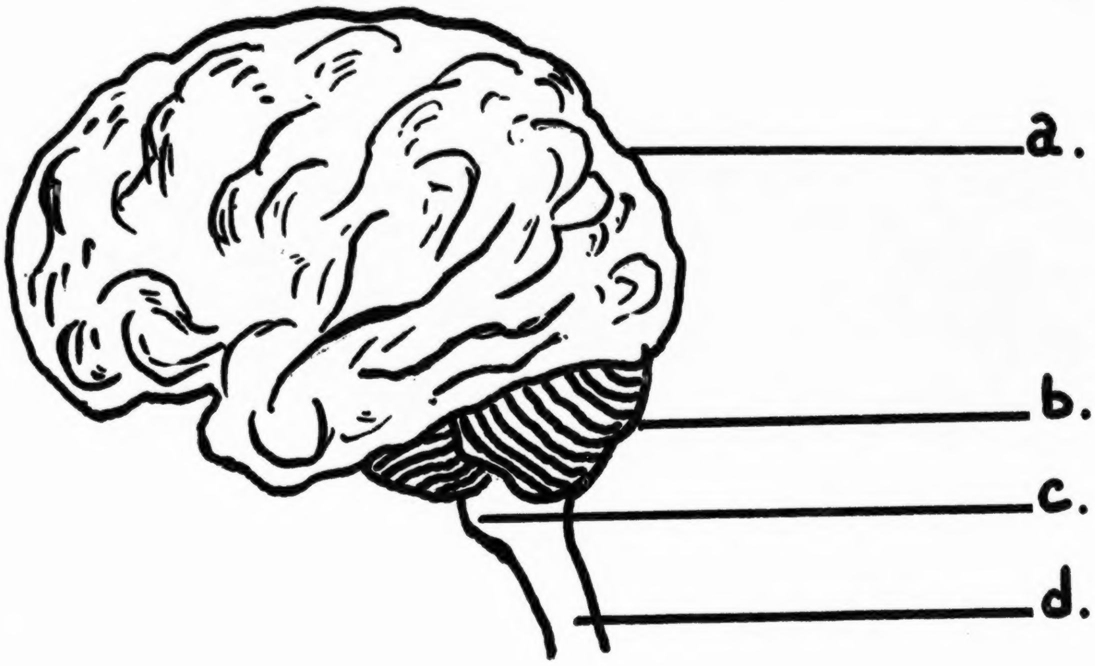
Let's See Your Body And How It Works, Shaw et al. F. A. Owen Publishing Co. Dansville, N.Y.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 28. How does our brain work?

MATERIALS:

diagram and description



PROCEDURE:

1. Compare your diagram with the model and label the 4 parts.
2. After you have labeled the diagram, the teacher will discuss with you what each part of the brain does.
   The parts of the brain control:

   a. memory, speech, sight, hearing, understanding
   b. balance and coordination of the muscles for standing, running, and walking
   c. breathing, heartbeat, coughing, sneezing, blinking
   d. pathway for messages between brain and the body

QUESTIONS:

1. What part of the brain helps you to see?
2. List three other functions that this part of the brain has.
3. If we could not stand up straight on our feet what part of the brain might be injured?
4. What part of our brain can be called our "engine"?
5. Why is the "engine" a good name for it?
6. What does the spinal cord do?

A. HEATING THE AIR

LESSON 1. Is the earth a radiator which helps to heat the air?

OUTCOMES:

1. The air touching the earth is heated by conduction.
2. The air near the earth can be heated by radiation.
3. Conduction and radiation are two ways in which heat can be moved.

MATERIALS:

a) Demonstration
piece of metal (paper clip)
Bunsen burner or alcohol burner
heat coil
glass plate
pupil worksheet, lesson #1

b) Pupil Activity
strips or rods of metal
candles
matches

PROCEDURE:

1. Motivate the lesson by saying, " If I were to ask you to sit on top of a warm radiator, you would probably think it a strange request. Yet, we know that when air is near the surface of the earth, it is warmed. Why is this so? Today, we shall see some of the different ways in which the air is heated by the earth."

2. Have a student hold one end of a thin piece of metal (a straightened out paper clip works well) while the other end is being heated. Tell the student to drop the metal when it feels warm. Ask the class why the student dropped the metal? Explain that the air touching the earth is heated by conduction just as the student's hand touching the metal was. Help the pupils define conduction as moving heat from one end of a thing to the other end of the same thing, or to something that is touching it.

3. To demonstrate radiation use a heat coil and place a glass plate above it, but not touching it. Have a student place his hand over the glass plate.

   This demonstration should follow the distribution of the worksheet so that the student can answer the questions on his worksheet as the teacher demonstrates.

4. Distribute copies of the worksheets and the following materials to all pupils. Have them perform the experiment in small groups. Have the teacher read the pupil worksheet with the class and explain each step.

   SUMMARY: After pupils have performed their experiment, have them explain how conduction and radiation heat the air close to the earth, so that it is warmer than the air high above the earth even though this air is closer to the sun.

PUPIL WORKSHEET

LESSON 1. How is heat moved from one place to another?

MATERIALS:

strip of metal or rod, wax candle and matches.

A. CONDUCTION:

1. Scrape some wax from the candle and place it near the end of the metal.
2. Wrap the other end of the metal with paper or cloth.
3. Stand the candle on a small dish on your desk and light it. Place the center of the metal over the flame. **Hold the end wrapped with paper.**

   a. The wax at the end of the metal ________ (freezes, melts).

   b. Heat ______ (moves, stands still) in metals.

   c. Paper ______ (lets, does not let) heat through it easily.

   d. Metals are _____ (good, bad) conductors of heat.

   e. Heat that moves in metals is called (conduction, radiation).

B. RADIATION:

Watch the teacher's demonstration and answer these questions.

a. Heat ______ (travels, does not travel) through glass.

b. The glass _____ (is, is not) touching the hot wire.

c. The heat _____ (can, can not) be traveling by conduction.

The heat is coming to your hand by radiation.

HOMEWORK:

Complete the chart by putting a check under conduction or radiation.

HEAT IS TRAVELING	CONDUCTION	RADIATION
1. A boy sits on a radiator		
2. A woman burns her hand on a stove		
3. A boy warms his hands by a fireplace		
4. The heat from a fire makes me turn away		
5. Air touching the earth gets warm		
6. A boy looking out of a window feels warm		

A. HEATING THE AIR

LESSON 2. How can we measure temperature?

OUTCOMES:

1. Heat causes materials to expand.
2. Liquid thermometers use alcohol or mercury as the expanding material to show temperature changes.
3. The freezing point on a Fahrenheit thermometer is 32 degrees; the boiling point is 212 degrees.

MATERIALS:

Teacher

air bulb thermometers (2)
incandescent light in a ceramic socket
beaker
ring stand and clamp
thermometer with range of 32 degrees to 212 degrees
tripod and asbestos screen
bunsen burner

Pupil

beaker containing ice cubes and water thermometer
small bottle or large test tube filled with water tinted red
rubber stopper with glass tube inserted and extending about six inches above the top of the stopper

PROCEDURE:

1. Partly fill the stems of the air thermometers with red tinted water. This is done by holding the bulbs in the palms of your hands for a few minutes and then placing the open ends in the tinted water. Remove your hands from the bulbs. As the air in each bulb cools liquid will rise into the tube.
   Show the class the two air thermometers with the liquid in their stems. Do not touch the bulbs. Ask the class if they can remove the liquid without breaking the tubes or touching the liquid with anything. Show the students the incandescent lamp. Tell them that you will use the lamp to force the liquid out. Place the lamp next to one of the air thermometer bulbs. The other serves as a control. Plug in the lamp. Have the pupils try to explain why the liquid moves down the stem. Point out that as the lamp heats the air in the tube, the air expands when heated and pushes the liquid out of the stem. The liquid may also be forced out of the stem by holding the bulb in your hand. State that this is how one type of thermometer works.

2. Distribute pupil worksheets and materials. Tell the students that they are going to see for themselves how liquid thermometers are constructed and how they work. Read the worksheet with the students.

3. As the pupils do their activity suspend a thermometer in a beaker of boiling water. have individuals from each group observe and record the reading of this thermometer on their worksheet (see pupil worksheet. question A,d.).

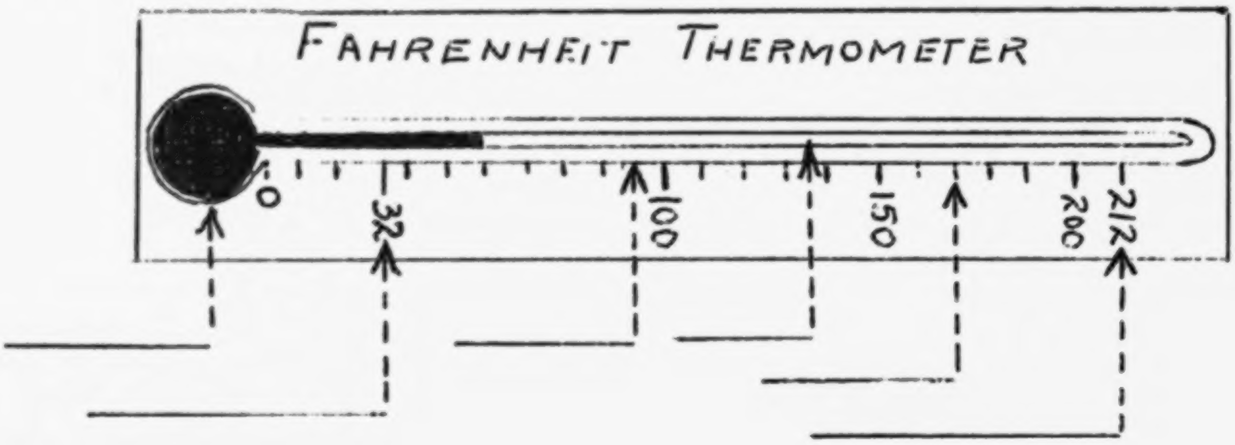
4. After the pupils complete their activities help them to complete their worksheets. Then ask the pupils to describe the liquids that they have seen in thermometers at home and in school. Elicit red and silver colored liquids. Some students may know what these liquids are. Point out that the red liquid is alcohol and the silver liquid is mercury. (Alcohol is ordinarily used in household-type thermometers because it is cheaper. It is also useful for recording very low temperatures which are below the freezing point of mercury (about-38°F). Mercury thermometers respond better to temperature changes and can be used to measure relatively high temperatures (about 680°F).

SUMMARY:

1. Summarize by having the pupils explain the effect of heat on materials, such as, liquids and air. The pupils may relate their own experiences with pots filled with liquid, being heated, and overflowing.
2. Have the children name and describe the liquids used in thermometers.
3. Elicit the method of determining the fixed points of 32 and 212 degrees on the thermometer.

HOMEWORK:

Have the students read the sentences and label the thermometer with the words underlined in the sentences.



1. The bore is the thin or narrow opening through which the liquid moves up or down.

2. The stem is the long glass tube which contains the narrow opening called the bore.

3. The bulb is the bottom or base of the thermometer which holds most of the liquid.

4. The freezing point of water is 32°F and the boiling point is at 212°F.

5. The scale is made up of the lines and numbers drawn along the edge or side of the thermometer.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

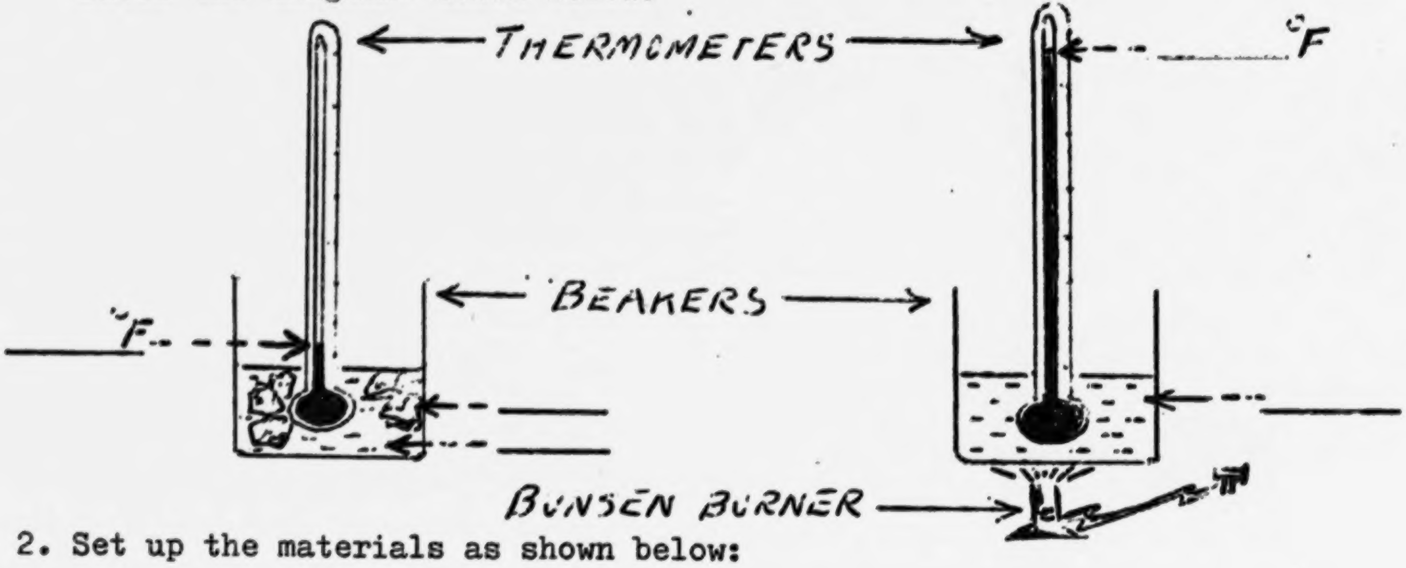
LESSON 2. How do thermometers work?

MATERIALS:

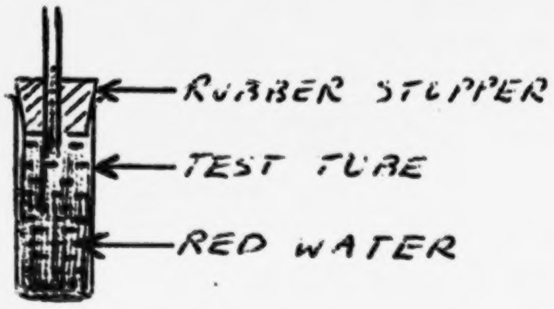
A. Beaker with ice cubes and water
   Thermometer (Fig. 1)
B. Test tube filled with red water
   Rubber stopper with glass tube
   Ring stand and clamp (Fig. 2)

PROCEDURE:

1. Place the thermometer in the beaker of ice and water. Stir slowly, with the thermometer for a few minutes.
   a. The liquid in the thermometer goes (up, down) ________.
   b. The liquid must be (expanding, shrinking) ____________.
   c. The liquid in the thermometer stops at __________ degrees.
   d. The thermometer in the boiling water on the teacher's desk reads ___________ degrees.
   Label the diagrams shown below:



2. Set up the materials as shown below:



Hold the test tube in your hand. Be sure your entire hand goes around the test tube. Watch the liquid in the thin glass tube.
a. The liquid in the glass tube goes (up, down) ____________.
b. The liquid in the test tube must have (expanded, contracted) _______.
c. The heat that made the water expand must have come from your ________.

A. HEATING THE AIR

LESSON 3. Can we measure temperature with a piece of iron?

OUTCOMES:

1. Two different metals, welded together, can be used to measure temperatures.
2. Bimetallic thermometers are less accurate than liquid thermometers.
3. The thermograph records temperatures on a chart.

MATERIALS:

Teacher

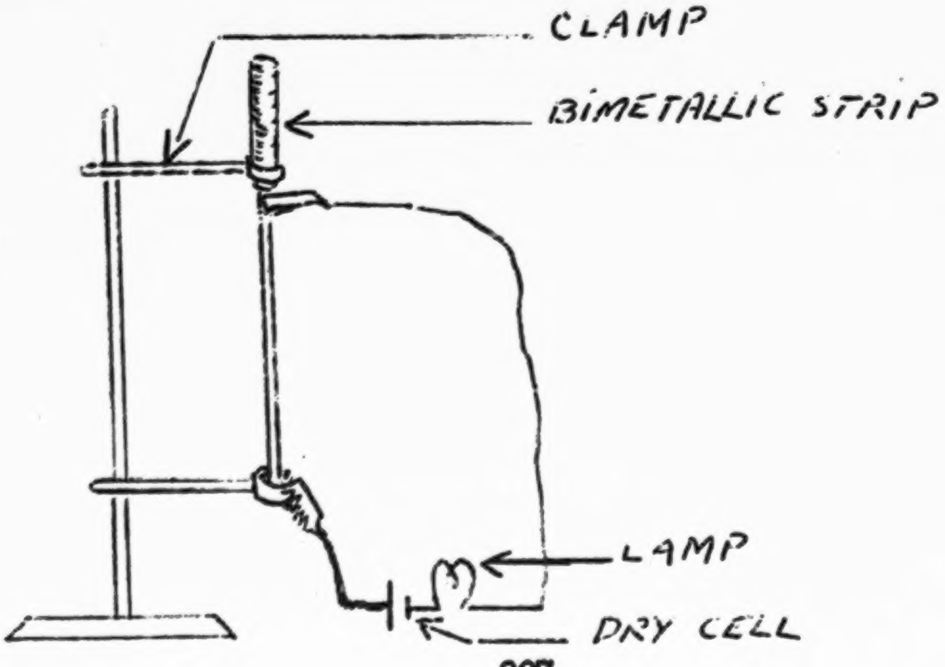
bimetallic strip
dry cell- $1\frac{1}{2}$ volts
lamp - $1\frac{1}{2}$ volts
socket for lamp
bell wire with alligator clips - 3 lengths about 12" each
2 clamps
ring stand
bunsen burner
(See diagram in procedure for set-up.)

Pupil

tin foil strip $\frac{1}{2}$" wide by 2" long (cigarette or food wrapper foil is suitable for this activity)
small block of wood (1"x 2"x 4")
file card (3" x 5")
one 100 - 150 watt light bulb mounted in a light socket on the teacher demonstration table (to be used by pupils to test their bimetallic thermometers)

PROCEDURE:

1. Motivate the lesson by displaying the following demonstration to the pupils.



2. Push the bimetallic strip against the bottom clamp. The light goes on. Tell the pupils that you can move the bimetallic strip without actually touching it or blowing on it. Ask the pupils how they think this could be done. Allow a few moments for suggestions. Heat the bimetallic strip. Ask the pupils what happened. Focus attention on the bimetallic strip.

3. Explain the bimetallic strip to the class. Describe it as being made of an iron and a copper strip welded or riveted together. Point out that one metal gets longer faster than the other when heated so that it forces the other strip to bend inward.

4. Encourage pupils to suggest why the bimetallic strip could be used to measure temperature.

5. Show the thermograph. Point out the coiled bimetallic strip. Briefly describe its operation. Point out that this thermometer is not as accurate as liquid type thermometers.

6. Distribute pupil worksheets and materials. Tell the pupils that they are going to make their own "metallic-type" thermometers.

SUMMARY:

Elicit the names of the parts of a bimetallic thermometer. Have the pupils recall that this thermometer depends on the uneven expansion of two different metals. Have the pupils recall the operation of the thermograph.

HOMEWORK:

When the pupils have completed the experiment, have them take it home and test it as directed on the worksheet.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

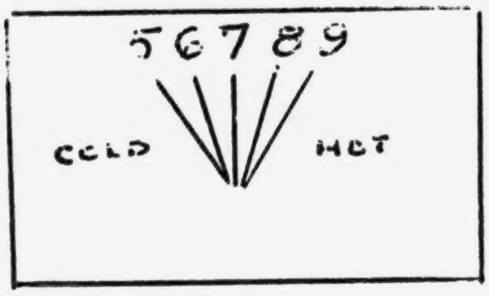
LESSON 3. How can we make a bimetallic type thermometer?

MATERIALS:

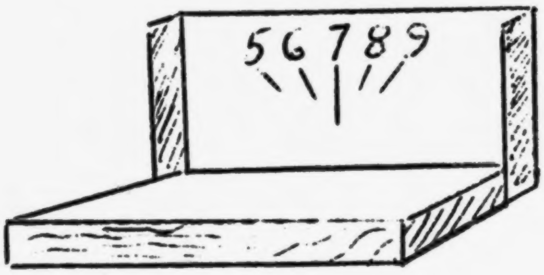
tin foil strip ½" wide by 2" long (cigarette or food wrapper foil is suitable for this activity)
small block of wood (1" x 2" x 4")
file card (3" x 5")
one 100 - 150 watt light bulb mounted in a light socket

PROCEDURE:

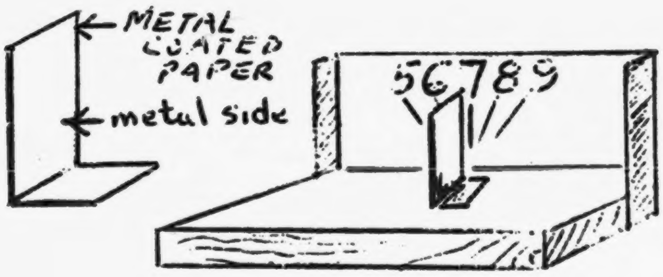
1. Place lines and labels on the 3"x5" card as shown.



2. Staple or tack the card to the block of wood as shown. Bend the sides.



3. Fold the metal coated paper as shown and tack it to the board.



4. Do the following and answer the questions below.
   a) Place your thermometer close to a lighted lamp on the teacher's desk. The metal coated paper bends towards the (hot, cold) ___________side. What happens when you take it away from the light?

   b) Take the thermometer home. See what happens when you place it near a window, on the floor, or inside the refrigerator. Leave the thermometer at least 10 minutes in each place. What happens?

   c) See if you can find a bimetallic type thermometer in your home, neighborhood, or school. Where did you find one?

A. HEATING THE AIR

LESSON 4. Why are summer days hot?

OUTCOMES:

1. Our part of the earth leans towards the sun in the summer.
2. Our part of the earth receives more direct sunlight in the summer.
3. The parts of the earth which receive the most direct sunlight get the hottest.

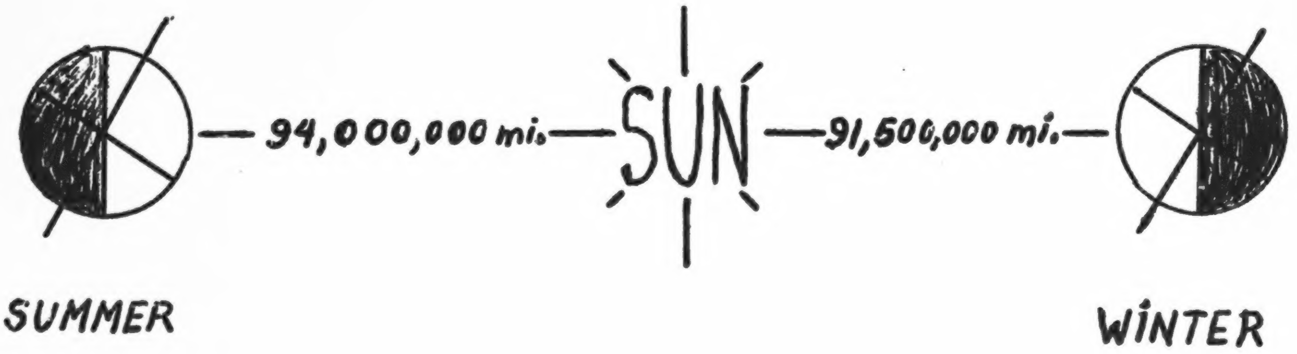
MATERIALS:

a. Demonstration
   Tripanzee Planetarium
   pupil worksheet, lesson #4

b. Pupil Activity
   cardboard square
   flashlight (or other source of light)

PROCEDURE:

1. Motivate the lesson by listing the following temperatures on the board - 96°F, 89°F, 92°F, 101°F, 104°F. Ask the children - "At what time of the year would you expect to find these temperatures?" Ask the students when do they think the earth is closest to the sun. Point out that actually we are closer to the sun in the wintertime. Show this in a diagram on the blackboard, showing the earth on opposite sides of the sun, as shown in the diagram below.



(continued)

2. Suggest the pupils think about the following question.
   Why are summer days so hot?
   Explain that the space between the sun and the earth is a vacuum and, therefore, none of the sun's energy is lost as it travels to the earth.

3. Using the Tripanzee Planetarium, show that the earth's axis leans towards the sun at one time of the year (summer) and away from the sun at another time of the year (winter) as it revolves around the sun. Tell the children that they are going to do an activity which will whow them why the leaning of the earth towards the sun causes summer days to be hot.

4. Distribute worksheets and materials to small groups of students. Read the directions along with the pupils.

SUMMARY: Show the Tripanzee Planetarium. Point out the tilt (leaning) of the earth's axis. Elicit from the students that when the earth leans towards the sun the season is summer, and when it leans away, the season is winter. Have the children recall that the part of the earth leaning away from the earth receives less heat and the part leaning towards the sun receives more direct rays which makes it hotter.

SUGGESTED HOMEWORK: Make a diagram of the earth showing how the United States receives more direct sunlight in the summertime than in the wintertime.

NOTE: The teacher may wish to use the science text booklets (Prentice-Hall) Energy Changes In The Atmosphere and Hydrosphere, Grade 8, for a diagram showing the amount of heat received by the earth.

PUPIL WORKSHEET

LESSON 4 Why is it hotter in the summer than in the winter?

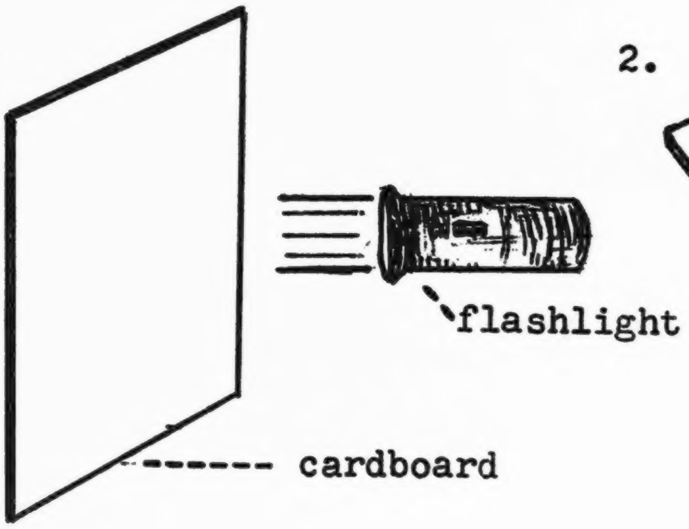
MATERIALS:

flashlight and cardboard square

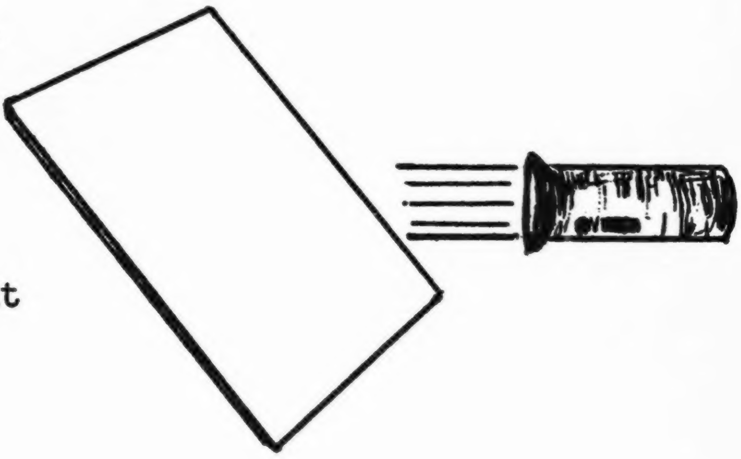
1. Place the carboard square in a straight line with the flashlight beam. See diagram below. Draw a circle around the flashlight beam where it hits the cardboard.

2. Lean the cardboard away from the light beam. See diagram. Draw a line around the light beam.

1.



2.



Fill in the sentences below.

1. The cardboard in a straight line with the light beam had an (even, uneven) __________ circle of light on it.

2. The card that leaned away from the light beam had an (even, uneven) _________ circle of light on it.

3. The spot of lot on the cardboard tilted away from the light beam was (more, less) _________ bright than the spot on the other card.

4. If the light beam was heat the cardboard leaning away from it would be (hotter, cooler) __________ than the other cardboard.

5. The part of the earth that leans away from the sun is (cooler, hotter) ________ than the part that is in a straight line with it.

6. When the earth leans towards the sun the United States is in a straight line with its rays. The United States is getting (more, less) _______ heat at this time. The season when this takes place is (winter, summer) ____________.

A. HEATING THE AIR

LESSON 5. Why does air rise when it is heated?

OUTCOMES:

1. Air that has been warmed will expand and rise.
2. Cool air is heavier and will sink.
3. The circulation of air is called convection.

MATERIALS:

a) Teacher Demonstration
   - yardstick
   - window pole
   - tissues
   - 2 paper bags or tin cans
   - string
   - thumb tacks
   - candle
   - matches

b) Pupil Demonstration
   - convection box
   - candle
   - touch paper
   - matches
   - tongs

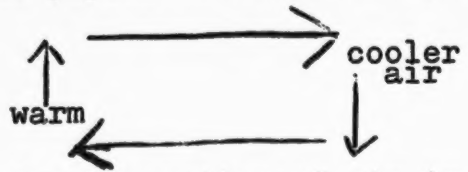
PROCEDURE:

1. Motivate the lesson by suspending a yardstick by a string from a stand so that it is balanced. Tape a paper bag at each end of the yardstick so that the open end faces down. Light a candle and place it under one of the bags. *Make sure* the candle is *not* near the bag. By questioning, *elicit* from the students that the bag goes up due to the rising hot air.
   Note- Tin cans can be used instead of paper bags.

2. Tack a tissue to the top of a window pole and demonstrate that the tissue blows out near a window open at the top while it blows in near the bottom open part of a window.

SUMMARY:

Ask the pupils to trace the path of the heated air.



This circular motion of air is called a *convection current*. Write the term and define on the blackboard.

Distribute pupil work sheet and material to small groups of pupils. Guide pupils in reading and understanding the activity they will do. Define new words.

NOTE:

In the pupil laboratory activity you may wish to use damp window shade cord instead of touch paper.

REFERENCES:

Teacher - Modern Earth Science, Holt, Rhinehart

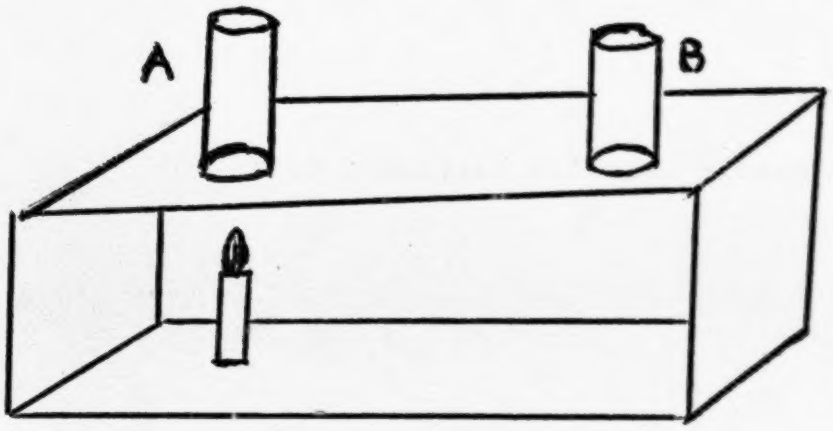
Pupil - You And Your Resources, Brandwein, et al.

PUPIL WORKSHEET
(May be duplicated for pupils)

Lesson 5. Why does air move in a circle?

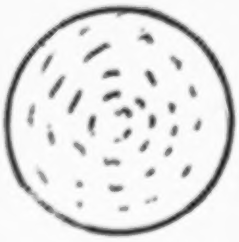
MATERIALS:

convection box	tongs
candle	matches
touch paper	



1. Light the candle in the convection box. Be sure to strike the match away from you.
2. Replace the glass slide.
3. While holding touch paper with tongs, light it.
4. Blow out the flame. Drop smoldering paper into chimney B.
5. The smoke ________ (rises, falls) in chimney B.
6. The air in chimney B must be __________. (rising, falling)
7. The smoke at chimney A is moving ________. (up, down)
8. The heated air at chimney A must be moving _________. (up, down)
9. Draw arrows in the picture to show the air moving in a circle.
10. We call air that moves in a circle a ____________ current.

HOMEWORK



Directions:

1) Cut along on the dotted lines.
2) Place a string through the center and tie a knot near the cardboard.
3) Hold the cardboard by a string and place it over a lighted candle.

Questions:

1. What happens to the cardboard?
2. Why did the heat from the candle make the cardboard turn?

Unit 8-4

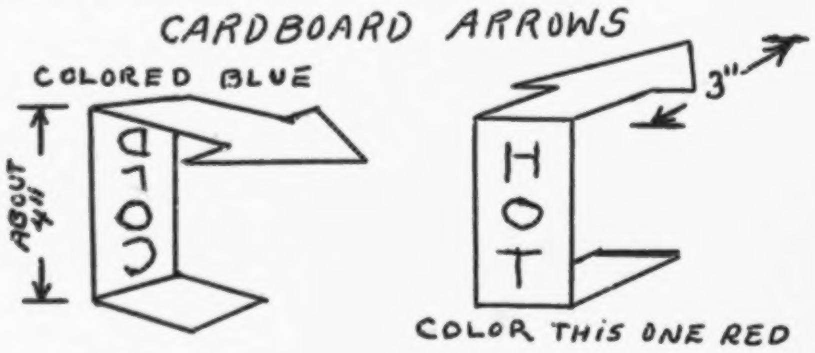
THE ATMOSPHERE, WEATHER AND OCEANS

B. WINDS

LESSON 6. What are winds?

OUTCOMES:

1. Winds are caused by the unequal heating of the earth's atmosphere.
2. Winds are the movement of air parallel to the earth's surface.
3. The spin of the earth causes winds to move away from their north-south paths.
4. New York is in the prevailing westerlies wind belt.



MATERIALS:

Teacher

convection box
smoke paper
large slate globe
medicine dropper
large globe of the world
two cardboard arrows (see diagrams above)
colored chalk - blue and red

Pupils

corrugated cardboard circle about 14" - 18" diam.
small pencil
3 x 5 card
marble or bead about ¼" to ½" diam. (wood, glass, plastic,etc.)

PROCEDURE:

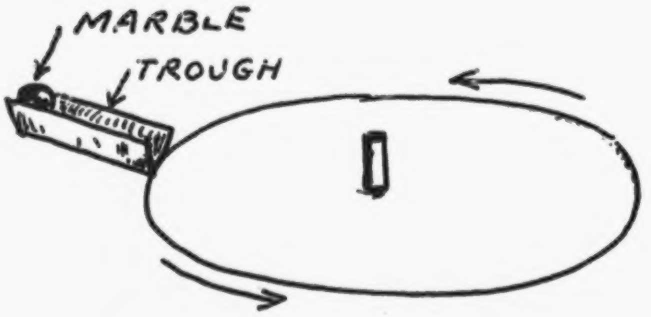
1. Review convection currents by having a pupil demonstrate and explain the operation of the convection box. Elicit from the pupils that heated air rises and cold air sinks.

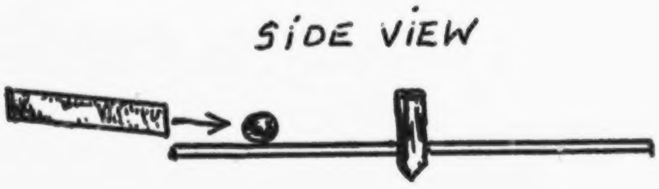
2. Show the pupils a large globe of the world. By questioning, elicit that the hottest part of the earth is around the equator and the coldest parts are at the poles. Draw a large circle on the blackboard and ask the pupils to label the Equator and the North Pole. Place two large labels on the circle - HOT at the Equator (red chalk), COLD at the North Pole (blue chalk). Have the pupils recall that hot air rises and cold air sinks. Draw a large red arrow moving away from the earth at the Equator. Draw a large blue arrow indicating cold air sinking at the North Pole.

3. Ask a pupil to tape the large red arrow at the place on the earth where hot air is rising. Do the same with the large blue arrow. The arrows indicate the path of the large convection currents that occur in the earth's atmosphere.

Point out that the movement of the rising and sinking air is not a wind, but this leads to the formation of winds. Show by means of arrows drawn parallel to the earth on the blackboard diagram of the earth's convection currents.

4. Distribute pupil worksheets. Demonstrate the proper technique for releasing the marble across the spinning cardboard disc. See diagram below.





This activity may be done as a pupil-teacher activity.
Assist the pupils with the reading and interpretation of the pupil worksheet.
Discuss, briefly, the results of this activity.

SUMMARY:

1. Have the pupils recall that the rising hot air at the Equator and the cold sinking air at the poles is similar to the motion of air in a convection box. Elicit that the moving air which follows the earth's surface is called a wind.
2. Demonstrate the deflection of winds by using the slate globe. Spin it slowly and allow a drop of water to run down its surface. Point out the curved path of the streak of water. Have the pupils relate this to the spinning cardboard disc and the moving marble. Point out that the water represents moving air.
3. Point out that winds moving north from the south are deflected to their right and appear to come from the south west. Show this by drawing the prevailing westerlies on the blackboard diagram or by showing a prepared diagram of the earth's wind belts. Show that New York is in the path of the prevailing westerlies.

HOMEWORK:

Give the pupils a rexographed copy of the world's wind belts. Leave out some of the labels. Have them find the labels in a textbook such as Energy Changes in the Atmosphere and Hydrosphere by Constant et al.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 6. What makes winds change the path along which they are moving?

MATERIALS:

corrugated cardboard circle about 14" - 18" diam.
small pencil
3 x 5 card
marble or bead about $\frac{1}{4}$" to $\frac{1}{2}$" diam. (wood, glass, plastic, etc.)

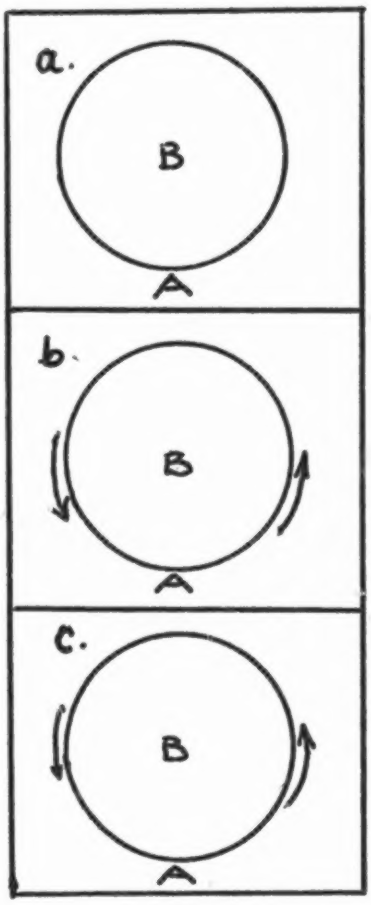
PROCEDURE:

1. Hold the card level.

   a) Roll the marble from A to B. Do this four times. Draw a line on circle A showing the path the marble follows.

   b) Spin the cardboard as shown by the arrows. Roll the marble from A to B again. Do this about four times. Draw a line showing the path of the arrow from A to B.

   c) Spin the cardboard. Roll the marble from B to A. Draw a line showing the path of the marble from B to A.



QUESTIONS:

1. In figure a the marble rolled in a (straight, curved) ___________ line.

2. In figure b the marble rolled to the (right, left) _____________ of B.

3. In figure c the marble rolled to the (right, left) _____________ of A.

4. Why did the marble change its path when the cardboard was spinning?
____
____

5. Use this experiment to explain why winds do not appear to come directly from the north or south. ____
____
____

B. WINDS

LESSON 7. How can we measure the speed and direction of the wind?

OUTCOMES:

1. Wind vanes show wind direction.
2. The anemometer measures wind speed.
3. Winds are measured in miles per hour and the direction from which they are blowing.
4. Winds far above the earth are measured by means of balloons.

MATERIALS:

Teacher

anemometer
wind vane
balloon inflated with natural gas or helium

Pupil

a. ping pong ball that has been halved
   soda straw
   thin finishing nail

b. soda straw
   pencil with eraser
   oak tag or 3x5 card
   straight pin

PROCEDURE:

1. Release the gas filled balloon in the classroom. Do not use hydrogen gas. To retrieve the balloon easily have a length of about six feet of sewing thread attached to its neck.

2. Release the balloon through a partially opened window. This can only be done when the classroom is in the proper location so that the balloon, which is carried by the wind, can be viewed by the pupils for a reasonable period of time. Have the pupils recall, from their own experiences, their observations of balloons carried away by the wind. You may find it more appropriate to do this activity in the school yard.

3. Elicit from the pupils that balloons could be used to measure wind speed and direction. Point out that winds above the earth are actually measured by this method (stop watches and telescopes are used).

4. Point out that winds above the earth have been clocked at about 200 miles per hour. Large airplanes have actually stood still (relatively speaking) when bucking the powerful winds of the jet stream which is about six miles above the earth.

5. Point out the need for having a permanent device for making continuous (minute by minute) measurements of wind speed and direction at the earth's surface.

6. Show an anemometer and wind vane. Demonstrate their operation. The wind stream could be produced by a fan, blowing at the instruments, walking quickly with the instrument held high, or the strong draft of an open window.

7. Elicit from the pupils that the anemometer cups catch the wind in the caved-in (concave) part and allow the wind to pass over the outward-curved (convex) part. Point out that its speed is measured in miles per hour.

8. Elicit that the larger wind vane surface, the tail, catches more wind than the arrow and is pushed away from the direction the wind is coming from. The arrow, therefore, shows the direction from which the wind is traveling. Point out that a north wind is traveling from the north.

9. Tell the pupils that they are going to make their own wind measuring devices. Distribute pupil worksheets and materials. Half of the class could make anemometers and the other half could make wind vanes. The completed instruments may be held in the hand to do the activities listed on the worksheet.

SUMMARY:

Have the pupils recall the names of the wind measuring instruments. Elicit the measurements that are derived from these instruments i.e., miles per hour and compass directions. Elicit that winds above the earth are measured by means of tracking balloons with telescopes and timing them with stop watches.

HOMEWORK:

Have the pupils try out their instruments outdoors and to make a record of their observations.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 7. How can we make an anemometer or wind vane?

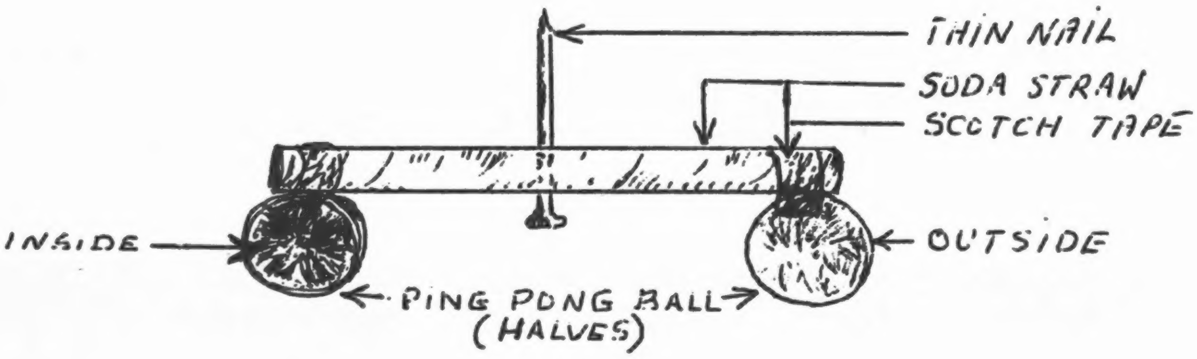
MATERIALS:

as shown in the diagram

PROCEDURE:

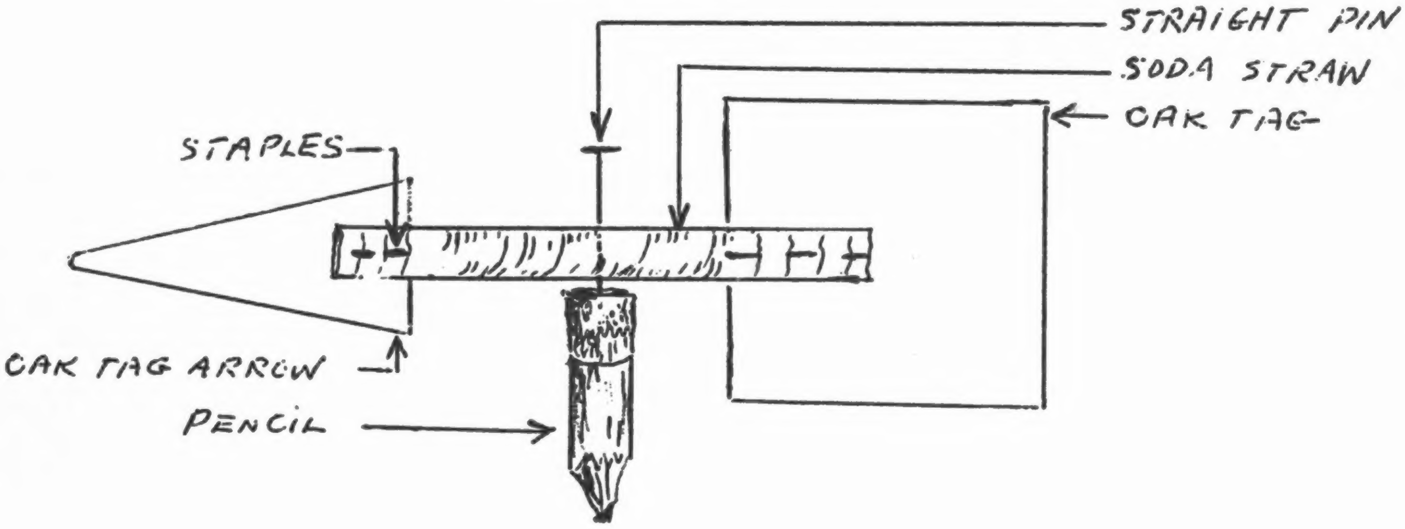
Put the materials together as shown in the diagrams Do the activities listed below each diagram.

The Anemometer


THIN NAIL
SODA STRAW
SCOTCH TAPE
INSIDE
OUTSIDE
PING PONG BALL
(HALVES)

From about one foot away blow at the hollow part of the ping pong ball. Now blow at the outside surface of the ping pong ball. It turns faster when the air hits it on the (inside, outside) ____________ surface.

The Wind Vane


STRAIGHT PIN
SODA STRAW
OAK TAG
STAPLES
OAK TAG ARROW
PENCIL

1. Blow at the wind vane from about three feet away. The (tail, arrow) ________________ moves away from you.
2. The arrow points in the direction from which the wind is (coming, going) ____________________.

B. WINDS

LESSON 8. Why is the ocean like an air conditioner?

OUTCOMES:

1. The ocean helps to cool the city in the summertime and to heat it in the wintertime.
2. Sea breezes help to keep our summer days from getting too hot.
3. The land gains and loses heat more quickly than the ocean.

MATERIALS:

Teacher

large map of the United States
large numbers on index cards as follows:

-60 -15 120 102

Pupil

2 beakers, 250 ml
sand (enough to fill one beaker)
2 thermometers
2 tripods
2 asbestos screens
2 alcohol burners
aluminum tray

PROCEDURE:

1. Display a large map of the United States. Place the following data on the map: Note: Temperatures are approximates.

   Lowest temperature: North Dakota (-60° F); New York City (-15° F).

   Highest temperature (excluding desert areas): Midwest (120° F); New York City (102° F).

2. Ask the pupils to study the map to see if they can discover something about New York City that makes its temperatures less extreme than the inland temperatures. Elicit or point out that New York City is near an ocean and the other area is far from the ocean. Pose the question,"How does the ocean affect our weather?" This may also be stated as,"Is the ocean an air conditioner?" Develop the idea that the ocean keeps New York City from getting too hot in the summertime and too cold in the wintertime. Point out that they are going to do an experiment which will help them to understand why the Atlantic Ocean helps to control our weather.

3. Distribute pupil worksheets and materials. Read the directions along with the pupils.

   Caution: The pupils must not handle the beakers or tripods once they are heated.

4. Demonstrate the proper way to insert the thermometer into the sand. It should be gently worked into the sand with a slight back and forth motion. The thermometer bulb should be about one half inch from the bottom of the beaker. A mark placed on the thermometer is used to indicate when the thermometer has reached the proper depth in the sand.

5. Check each set-up as the beakers heat. The sand will conduct heat to the thermometer after the removal of the heat source; therefore the burner should be removed before the thermometer reading reaches about 140°F. Note: The burner flame should just touch the screen.

6. After the heating process is stopped, discuss the development of sea breezes in the summertime. A diagram on the board or previously prepared on acetate could be used to demonstrate the causes of sea breezes. The pupils should be aware that the land areas heat up faster than the nearby ocean. This may be related to their own experiences with the hot sands at the beach and the much cooler ocean (about 65° - 70°F). Develop the concept of warm air rising and cooler air moving in to take its place.

7. Assist the pupils in completing their worksheets. Elicit the following:

   a. sand heats up better than water
   b. sand cools faster than water

   Relate these concepts to explain that the ocean is warmer than the land in the winter. Therefore, it acts as a radiator which helps to warm the nearby land areas when air that has been warmed by the ocean moves in over the land.

SUMMARY:

Summarize by eliciting that land areas heat quickly and cool quickly; water areas heat slowly and cool slowly. Elicit the development of sea breezes as the land areas heat up quickly during the daytime causing the cooler ocean air to take the place of the rising hot air over the land areas.

HOMEWORK:

1. Place your hand near the bottom of an opened refrigerator. The air feels (cool, warm) ______________.

2. Place your hand at the very top of an opened refrigerator. What do you feel?

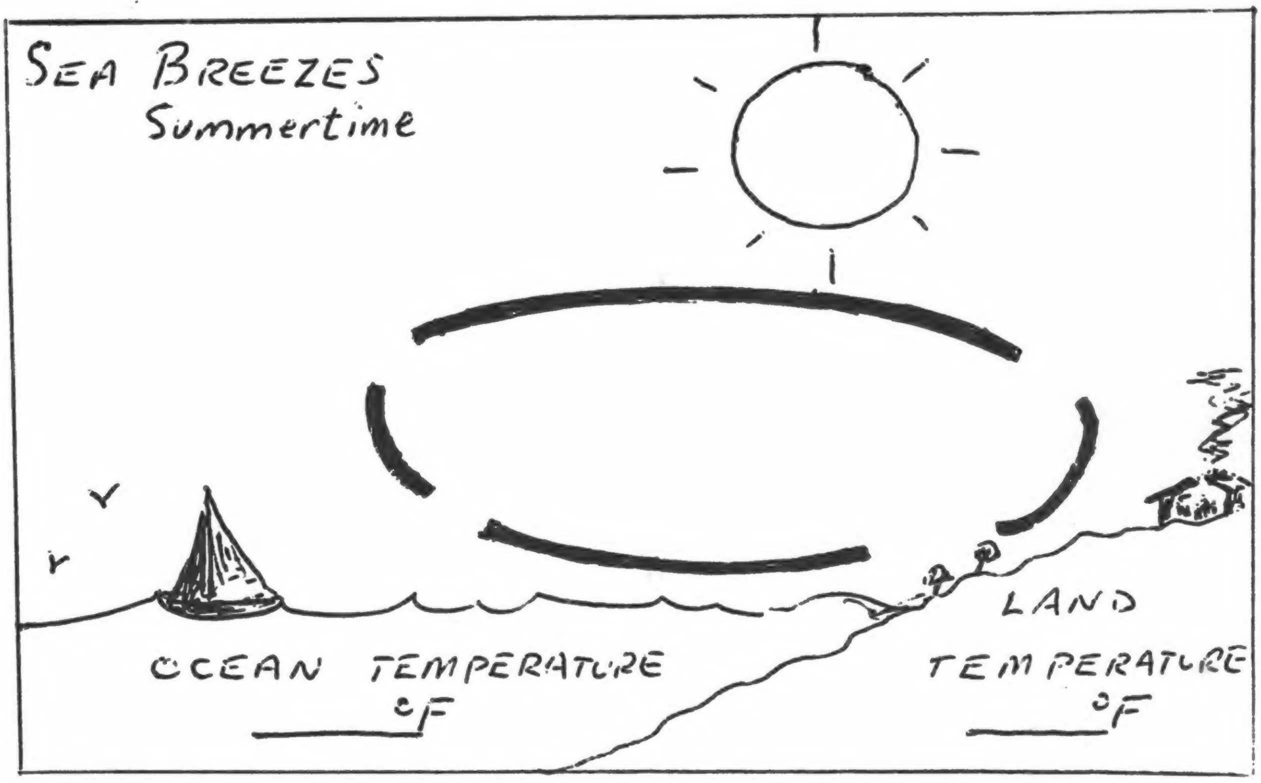
3. Place your hand about one foot above a warm radiator or stove. The air feels (cool, warm) ________________________.

4. In your own words tell why you feel the cold or warm air at different places. Can you tell how these differences are somewhat the same as sea breezes?

5. Sea Breezes
   Summertime

   a. Place the following temperatures in the blank spaces of the picture shown below: 90°F and 70°F.

   b. Draw arrows on the dark lines to show the direction of movement of the hot and cold air.


SEA BREEZES
Summertime
OCEAN TEMPERATURE
______ °F
LAND
TEMPERATURE
______ °F

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

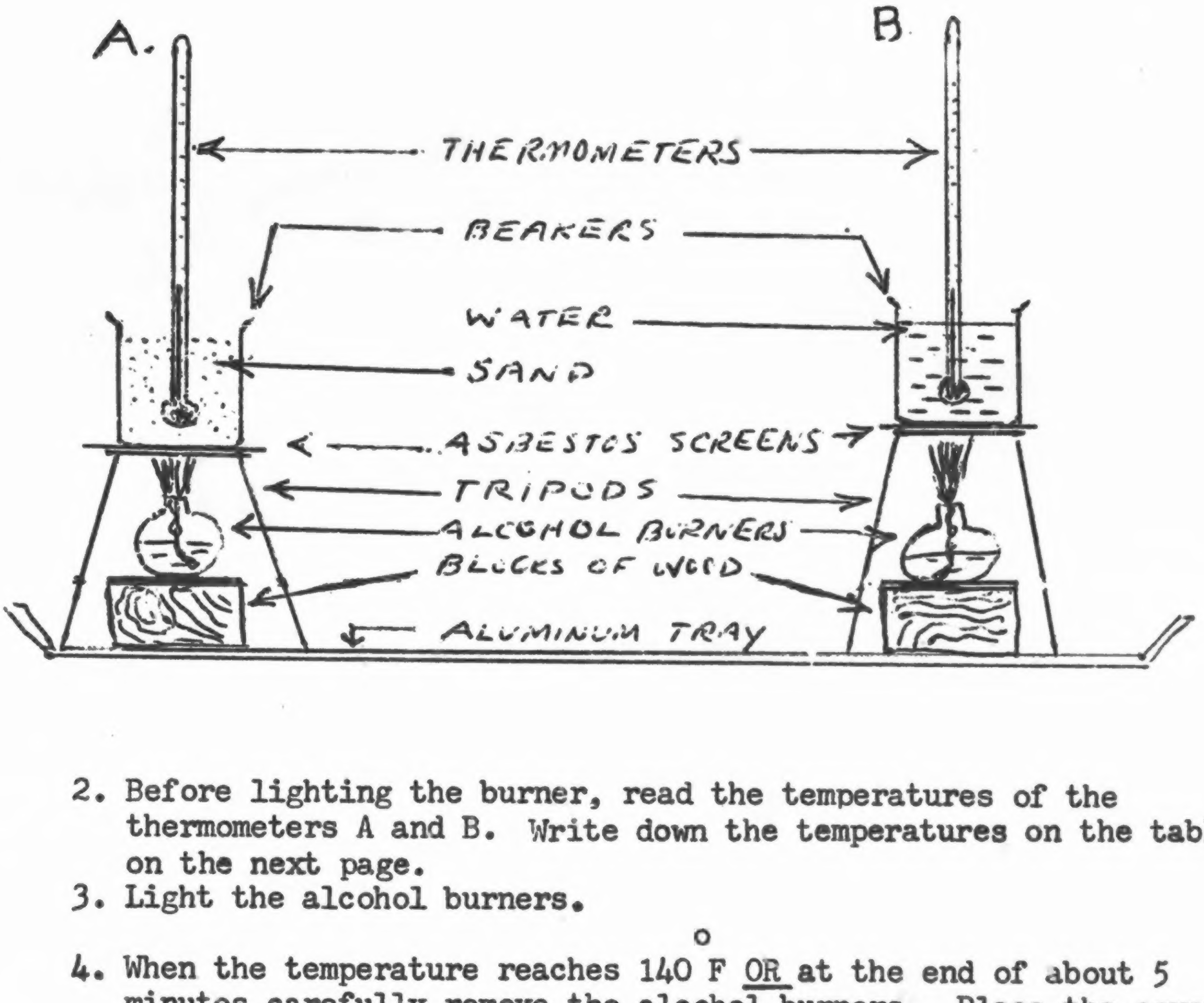
LESSON 8. Does land heat up faster than water?

MATERIALS:

metal tray
1 beaker 3/4 filled with cool tap water
1 beaker 3/4 filled with sand and soil
2 thermometers
2 alcohol burners
2 tripods
2 asbestos screens

PROCEDURE:

1. Set up your materials as shown in the diagram below.


A.
B
THERMOMETERS
BEAKERS
WATER
SAND
ASBESTOS SCREENS
TRIPODS
ALCOHOL BURNERS
BLOCKS OF WOOD
ALUMINUM TRAY

2. Before lighting the burner, read the temperatures of the thermometers A and B. Write down the temperatures on the table on the next page.
3. Light the alcohol burners.
4. When the temperature reaches 140° F OR at the end of about 5 minutes carefully remove the alcohol burners. Place the covers over the wicks.
5. Record the temperature of the sand and water after about 2 or 3 minutes.

6. Do not touch your set-up. You will take more readings later in the period.

7. Fill in the temperatures in the table below at the time shown in a-b-c-d.

TABLE

	A	B
	TEMPERATURE	
	SAND	WATER
1. Before heating	1	
2. After heat is removed	2	
3. A few minutes after heat is removed	3	
4. After cooling about ten minutes	4	

8. Answer the following questions:

a. The sand temperature in number three was _______________ °F.

The sand temperature in number one was _______________ °F.

The sand temperature went up _______________ °F.

b. The highest water temperature was _______________ °F.

The water temperature before heating was _______________ °F.

The water temperature went up _______________ °F.

c. (Sand, water) ____________________ heats up faster.

(Sand, water) ____________________ cools more slowly.

C. MOISTURE IN THE AIR

LESSON 9. How can an ocean be placed in the sky?

OUTCOMES:

1. Evaporation is a change from a liquid to a gas.
2. The gas is called water vapor.
3. Water vapor is formed from the life activities of plants and animals, as well as from bodies of water.
4. Water evaporates faster with heat and wind.

MATERIALS:

Teacher

water
beaker
bunsen burner
matches
tripod
chalkboard
tin can

Pupil

brown paper (bag)
jar of water
tripod
tray
matches
candle or alcohol burner

PROCEDURE:

1. Make a smear on the chalkboard with a wet rag. As the water on the board evaporates ask,"Where did the water go? Why can't we see it? Is it still a liquid or has it changed?"

2. Heat a pyrex test tube containing about one inch of water. Before heating place a one-hole stopper in the test tube with a piece of glass tubing extending about two inches past the rubber stopper. Guide the pupils to identify that the space between the boiling water and the steam is water vapor, while the steam is water vapor which has cooled off (condensed) to small droplets.

3. Ask, "What happens to all the water that goes into the air?" Guide the discussion so that pupils realize that air gains water vapor by evaporation from bodies of water, from animals (respiration) and from plants (transpiration).
   You may wish to show that plants give off water by covering a plant with a plastic bag for a few days and then have the pupils notice the water on the inside of the plastic bag.

4. Distribute the pupil worksheets and materials. Read the instructions with the students and guide them in setting up the experiment.

5. Have the pupils complete the homework shown on the pupil worksheet.

SUMMARY:

Water vapor is a gas found in the air which is formed by the evaporation of water from plants, animals and bodies of water.

REFERENCE:

Science - Davis, Burnett, Gross 1961 p. 131

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 9. How can we dry wet things fast?

MATERIALS:

brown paper(bag)
jar of water
tripod
tray
matches
candle or alcohol burner

PROCEDURE:

Place the jar of water on your tray and keep it there to prevent the spilling of water on the desk and floor. Tear a piece of brown paper large enough to fit on top of the tripod. Wet the paper thoroughly and place it on the tripod. Warm the wet paper with a candle or an alcohol burner. Place another piece of wet paper on the tray. Compare the results.

1. What happened to the wet paper when it was heated?

2. The water from the paper (evaporated, burned) ______________.

3. Heat (helps, does not help) ________________ water evaporate faster.

Wet another piece of brown paper, wring it out, and tear it in half. Crumple one half and place it on the tray. Stretch out the other half and fan it.

4. The fanned paper drys (first, last) ___________.

5. Wind (helps, does not help) ______________ water evaporate faster.

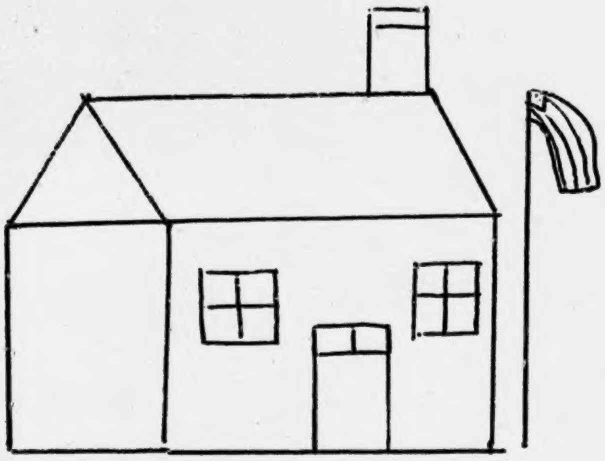
6. Water gets into the air by ______________.

7. Heat and wind (speed up, slow down) ______________ evaporation of water into the air.

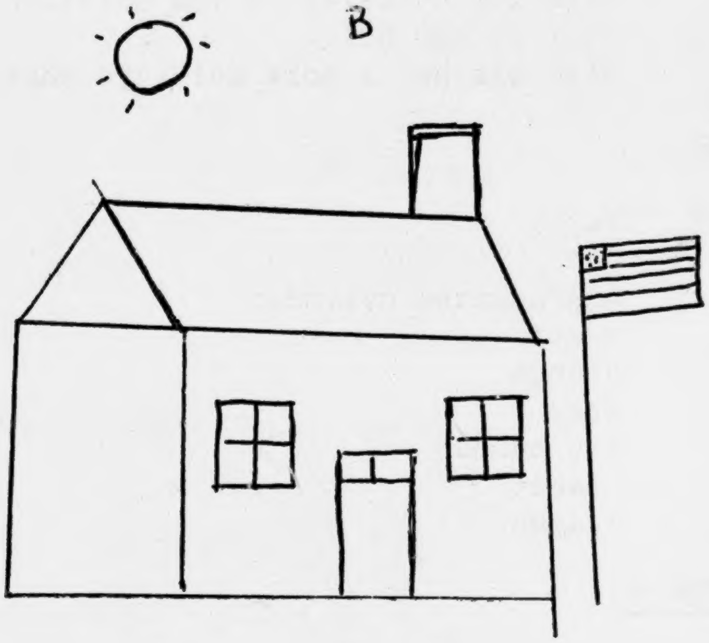
HOMEWORK:

1. If you hang clothes on a line. in which picture below would you expect the clothes to dry faster? Why?

A



B



2. How does a clothes dryer help dry clothes?

3. Which would dry faster, a bundle of wet clothes or clothes hung on a line?

C. MOISTURE IN THE AIR

LESSON 10. How much water can be found in the ocean in the sky?

OUTCOMES:

1. The amount of moisture in the air is called humidity.
2. Relative humidity is the moisture the air is holding compared to what it can hold.
3. Warm air holds more moisture than cold air.

MATERIALS:

Pupil

ungraduated cylinder
water
sponge
tray
ice cubes
beaker
crayon

PROCEDURE:

The procedure outlined below will serve as a motivation to explain relative percent.

1. Have a pupil stand in front of the room and extend one arm about three inches above the teacher's desk. Ask another pupil in the class to place textbooks on the first pupil's outstretched hand until the pupil can no longer hold any books and his hand drops to the desk. Write the number of books on the board. Let us assume the number is 10. Now place 5 books on the boy's arm. Can he hold it? The number of books he is now holding (5) compared to the number of books he held before (10) is called the relative percent.

2. If time permits, guide the pupils to see the relationship of $\frac{5}{10} = \frac{1}{2} = 50\%$. Stress the meaning of the term Relative Percent in terms of humidity.

3. Distribute pupil worksheets and materials to small groups of pupils. Read the worksheet with the class to make sure they understand the directions.

NOTE:

Have the pupils perform this experiment over a lunch tray to avoid the problem of spilling water.

SUMMARY:

Review the meaning of the terms relative percent. Encourage pupils to define the meaning of the terms humidity and relative humidity. Elicit pupil suggestions as to what effects the relative humidity.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 10. What is relative humidity?

MATERIALS:

unmarked cylinder
water
sponge
tray
ice cubes
beaker
crayon

PROCEDURE:

1. Soak a sponge in water for about ten seconds. Squeeze the water out of the sponge into an unmarked cylinder. Mark the top level of the water with a crayon.
    a) The crayon mark shows the sponge was (half full, full)________ of water.
    b) This means the sponge was (100%, 50%)___________full.

   Empty the cylinder. Quickly dip the sponge in water. (Don't let it stay in for more than a second). Squeeze the water into the cylinder and mark the top level with a crayon.
    c) Is the water as high as the first crayon mark?(Yes, no)______
    d) Compare your second crayon mark to the first one. Is it (3/4 , 1/2 , 1/4) _________of the height of the first crayon mark.
    e) The relative percent of the second crayon mark is (75% , 50% , 25%) _________.

2. Place ice in a beaker.
    a) Breathe out in the room. You (do, do not) _______ see your breath.
    b) The warm air of the room holds (less, more) _________ water vapor than the cold air near the ice.

   Remember - Warm air holds more moisture than cold air.

HOMEWORK:

1. Complete the following chart:

Water Vapor in Air	Water Vapor Air Can Hold	HUMIDITY
10	100	
75	100	
20	100	

2. a) What happened to the moisture in your breath when you exhaled into the room?
   b) What happened when you exhaled over the ice?
   c) Which air (warm or cold) can hold more moisture?

C. MOISTURE IN THE AIR

LESSON 11. How can we make an instrument to measure the water vapor in the air?

OUTCOMES:

1. Evaporation is faster on a warm, windy day.
2. Evaporation is a cooling process.
3. To measure humidity we use instruments called hygrometers.

MATERIALS:

Pupil

thermometers
tape
ring stand and clamp
absorbent cotton or guaze
beaker of water

PROCEDURE:

1. As a motivation ask, "How does the water vapor in the air affect you?" Have the pupils recall personal experiences such as windows and drawers being stuck and hair hard to manage on damp days.

2. Review the meaning of the term "evaporation" by placing two streaks of water on the board and asking the pupils how to increase the speed of evaporation. Have the pupils explain that heat and wind hasten evaporation.
   Distribute the materials and worksheets to small groups of pupils. Read the worksheets with the pupils as they perform the experiments.

SUMMARY:

When the humidity is high, our hair is hard to comb, and our clothes dry slowly. To increase evaporation we can use heat and wind.

HOMEWORK:

Perform the experiment outlined on the pupil worksheet.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

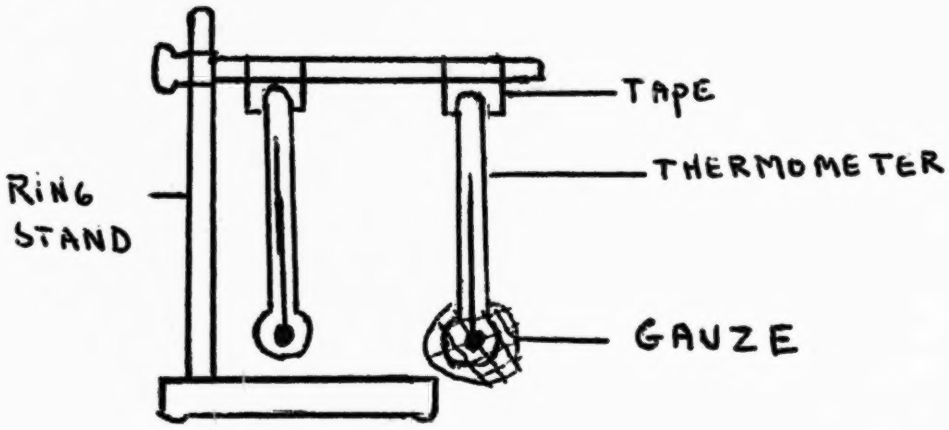
LESSON 11. How do we make an instrument to measure humidity?

MATERIALS:

thermometers
tape
ring stand and clamp
absorbent cotton or gauze
beaker of water

PROCEDURE:

To find the humidity of the room, set up the materials given to you as shown in the diagram.



Attach the wet gauze or absorbent cotton by tying it around the bulb of one of the thermometers. Fan it slowly.

1. Evaporation of the water from the gauze (lowered, raised)__________ the temperature on the thermometer.

2. Record the dry bulb reading.____________________

3. Record the wet bulb reading.____________________

4. Subtract the wet reading from the dry reading.______________________

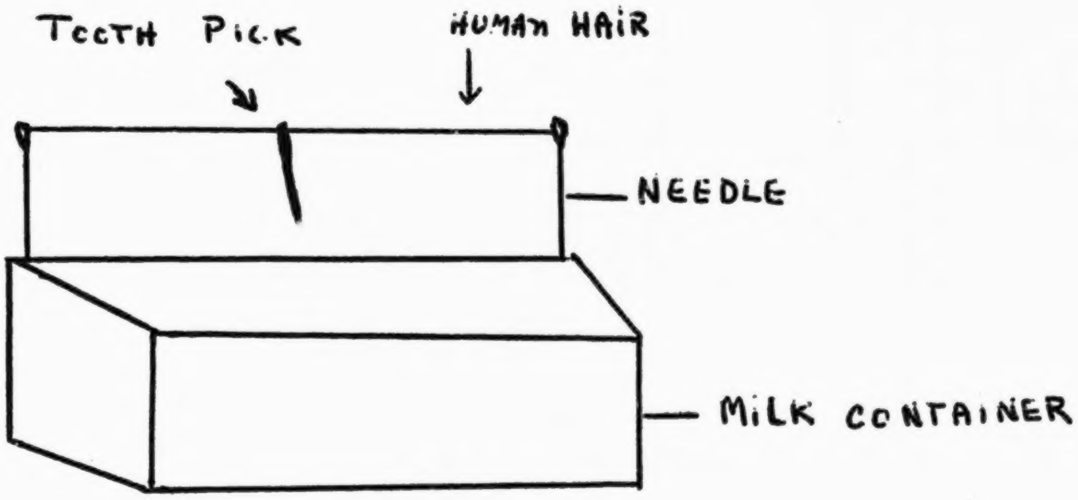
Using the humidity table on the following page find the relative humidity of the room.

Dry bulb	2	4	6	8	10	12	14
70	90	81	72	64	55	48	40
72	91	82	73	65	57	49	42
74	91	82	74	65	58	50	43
76	91	82	74	66	59	51	44
78	91	83	75	67	60	53	46
80	91	83	75	68	61	54	47
82	92	84	76	68	61	55	48
84	92	84	76	69	62	56	49

5. If the dry bulb is 74 and the wet bulb is 68 what is the relative humidity? Use the table to find the answer.

HOMEWORK:

You can make another type of HYGROMETER to measure humidity at home by using very simple things. This can be done by using a milk container, needles, human hair, and a toothpick and putting them together as shown in the picture.



After you have set up the materials, wet the hair. This represents 100% humidity. Mark the spot where the toothpick points 100. Mark the opposite side 0. Mark the halfway point 50.
Record the relative humidity in your house for three days and bring in the results.

C. MOISTURE IN THE AIR

LESSON 12. How can our streets get wet without rain?

OUTCOMES:

1. A change from a gas (invisible water vapor) to a liquid (visible water) is called condensation.
2. Condensation takes place when the air cools and holds less water vapor.
3. Condensation leads to the formation of dew and fog close to the ground.
4. Frost occurs when condensation takes place at below freezing temperatures. This changes the vapor directly into ice rather than water droplets.

MATERIALS:

Teacher

flask
one-hole stopper
glass tube
test tube
test tube holder
tripod

Pupil

milk bottle
ice cubes
hot water
salt
tin can

PROCEDURE:

1. Place a one-hole stopper containing a small piece of glass tubing bent at a right angle into a flask one fourth filled with water. Heat the flask and place a test tube over the glass tubing.
   Note: Hold the test tube with a test tube holder as it may get hot. Elicit from the pupils that evaporation is taking place in the flask as the water boils. The water vapor rises and enters the cooler test tube. Since the air in the test tube is cooler, it cannot hold as much water vapor and the water vapor changes into water droplets. The change from a gas to a liquid is called condensation.

2. Use the questions below to explain the formation of dew. Relating to their experiences, elicit that the sand at the beach at night is cool and moist.

   a) At night the (earth, air)_________ is usually cooler.
   b) If there is a lot of water vapor in the air, it would condense on (warm, cold) ___________ objects.

Water vapor would condense on objects which cool of fast such as land, grass, cars, etc. This wetness (condensation) is called dew.

3. Distribute the pupil worksheets and materials. Go over the worksheets with the pupils as they do the experiments to make sure they understand the directions and perform their tasks correctly.

NOTE:

The hot water required for the pupils' experiment can be obtained from a hot water faucet. If none is in the room make provisions to have some on hand at the appropriate time.

SUMMARY:

Review the words evaporation and condensation to make sure their meanings are clear. Relate the effect of air cooling during the night to water vapor condensing out of the air in the form of fog and dew.

HOMEWORK:

1. Why does the inside of your window get wet during the winter?
2. Why does the inside of your window freeze on very very cold nights?
3. Why is it possible for you to see your breath on cold days?

REFERENCE:

New York State Education Department, "General Science Handbook", Part 3, page 163, 1956

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 12. Where does fog and frost come from?

MATERIALS:

milk bottle
ice cubes
hot water
salt
tin can

PROCEDURE:

1. Fog
Fill a milk bottle with hot water. Then, pour out most of the water leaving about an inch in the bottom. Place an ice cube on the mouth of the bottle. Observe what happens.

a) When you poured most of the water out of the bottle, the air in the bottle was (warm, cold) ______________.
b) This air was holding (a lot, little) ______________water vapor.
c) The ice cube caused this air to (cool, heat) __________.
d) Cold air holds (less, more) _____________ water vapor than warm air.
e) The water vapor (evaporated, condensed) ________________ to form the fog we saw appear.
Remember fog is a collection of tiny water droplets which condensed from water vapor.

2. Dew and Frost
Place a few ice cubes in a shiny tin can and observe the droplets of water forming on the outside of the can.

a) The drops of water on the outside of the can came from the air (inside, outside) _________________ the can.
b) The water vapor condensed because of the (coldness, shine) _________ of the can.
Place 3 or 4 ice cubes in a towel or handkerchief and hit it against the desk until the ice is crushed. Mix the crushed ice and salt in a can and stir it.
c) What forms on the outside of the can?_______________________________
Hint: This happened because the salt mixed with the ice made the can very cold.

Remember
When water vapor nearest the earth condenses on cool objects, it forms dew. If the object is very, very cold the water vapor changes directly into ice. It is then called frost.

C. MOISTURE IN THE AIR

LESSON 13. How can we make a cloud?

OUTCOMES:

1. Clouds are formed when the air cools causing the water vapor to condense around some particle in the air.
2. Rain falls when the water droplets in the clouds become too heavy to float.
3. Snow is formed at freezing temperatures as the water vapor turns directly into snow crystals.

MATERIALS:

Teacher

flask
one-hole stopper
rubber tubing
pump
glass tubing

PROCEDURE:

1. Place about 10 drops of water or rubbing alcohol in a flask to provide particles on which the water vapor can condense. Insert a one-hole stopper in the flask and connect it by means of a tube to an air pump. Pump air into the flask. When the cork pops out, the pressure is lowered causing the air to suddenly cool. The water vapor condenses to form a cloud.

2. Elicit the correct responses to the following questions:

   a. The water in the flask (increased, decreased) _______________ the humidity.
   b. Pumping air into the flask (squeezed, spread out) ___________ the air.
   c. The air became (warmer, cooler) _______________.
   d. When the cork popped out, the air suddenly (warmed, cooled) _______________.

3. Try the experiment without putting water or rubbing alcohol in the flask to show the need for condensation nuclei.

   Distribute the pupil worksheets and inform the pupils that they will be reading a story about weather in their own language. Pupils should answer all questions on the worksheet.

SUMMARY:

Review the steps in the changing of water into a vapor and back into a liquid again because of the cooling of air. Stress the important ideas that warm air holds more vapor than cool air and that as the rising warm air cools, it releases the vapor because it cannot hold that much water. Point out that in order for droplets to form, particles (dust, salt, soot, etc.) must be present.

HOMEWORK:

Finish the worksheet at home.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 13.

Walter the Water Drop

Part 1 - Rain

One sunny day, Walter the water drop was cooling his heels (resting) in a large ocean with a bunch of drips (other water drops). The sun was beating down something fierce, but instead of sweating as most cats (people) do, Walter began to fade (disappear). He was gone. No longer was Walter a drip (water drop). He was floating high up above the crowd. He had split (left). Walter had become a gas. The higher up Walter went, the colder it got. Walter was cool enough by now. He had had it. He reached out looking for something to cling to and found a speck of dust. Other water vapors stuck by Walter. There were no chickens (cowards) in this group. They also grabbed specks of dust and then had a crying session in which they decided not to split. They gathered from all over to make the cloud scene.

Man! Those water drops were floating in that cloud. It became a hip place. More and more drips (water drops) joined them. Soon the cloud became so heavy it could no longer hold Walter and his hip crew. Down they fell. They had made it. Yes, they had turned into rain.

1. Water turns into water vapor when it is (warm, cold) ____________.

2. Water vapor is (lighter, heavier) ________________ than air.

3. The farther we go from the earth, the(warmer, colder) ___________ it gets.

4. Water vapor is a (gas, liquid) __________________.

5. Rain falls when a cloud becomes (heavy, light) ________________.

Part 2 - Snow

Walter fell from the cloud, and landed in a large lake with some of his gang. He stayed awhile waiting for the action and it soon came.

The hot sun glared at him and caused Walter to fade once more. He was floating again. This time he hit a real cool reception . It was below freezing high above Mother Earth. Poor Walter didn't change back to water. He was so cold that he became a snowflake. None of the mob with Walter dared call him a snowflake. After all, they too were snowflakes. To make the situation even more embarrassing, Walter soon fell to the earth where a little boy made him part of his snowman.

True or False

1. Snow is frozen rain. ______________________

2. Snow is frozen water vapor. __________________

3. Snow can form if the temperature is 42 degrees. ______________

Part 3 - Sleet and Hail

Walter's embarrassment ended when he evaporated again and joined the cloud gang. He wanted to come down as a rain drop, go through cold air, freeze and reach the earth as sleet. However, he heard tales of a wise guy who wasn't going to let him fall to the earth. Walter started out as a drop of water, went through some cold air to get a sheet of ice around him and headed for the earth. Up came the wise guy looking for trouble. He was heading upward, just a big bag of wind. Down came Walter. Up came the wind. Boom! Up went Walter, a tear forming over his ice coat. What a shot that was. But Walter was tough. He went into the cold air again and got another coat of ice. Boom! The wind was too strong. Walter went up again and again until he had many coats of ice. He was heavy, he was tough. He crashed right through that wind. HAIL WALTER. That's right, Walter was hail. He fell to the earth, melted and finally wound up back in the ocean with all the hip cats.

1. Sleet is frozen (rain, snow, water vapor) ____________________.

2. Hail can't fall to the earth because (its too light, air keeps pushing it up) ____.

3. Hail has (one, many) ______________________ coats of ice.

D. AIR PRESSURE

LESSON 14. What is the weight of all the air in our classroom?

OUTCOMES:

1. Air is matter and takes up space.
2. A cubic foot of air weighs about 1.2 ounces.
3. Air exerts pressure because it has weight.

MATERIALS:

Teacher

1 gallon tin
2 plastic bottles about 1 gallon capacity
paper toweling
1 beaker
1 test tube
1 battery jar

PROCEDURE:

1. Place two large plastic bottles one empty and one filled with water on the demonstration desk. Ask one of the pupils to pick them up. Ask him which gallon container he would prefer to carry one mile. Ask him to tell the class why. The response should be that the container is light. Elicit that the bottle is empty.

2. Discuss the possibility that the "empty" bottle is not really empty. Have one pupil squeeze the bottle and instruct another pupil to hold his hand near the mouth. He should note that air is coming out of the container. Elicit that the container is not really empty.

3. Place a tissue or a child's (clean) handkerchief or scarf inside a beaker or other glass container. Be sure it is a reasonable distance away from the open end of the container. Submerge it, open end down, in the water. Lift the container out of the water. Hand the scarf to its owner. Have him note that it is dry. Point out or elicit that the water in the container cannot wet the scarf because it cannot occupy the space already occupied by the air in the container.

4. Elicit that since air is matter and takes up space it has weight. Tell the pupils that one cubic foot of air weighs a little more than one ounce. Ask the pupils what they think is the total weight of all the air in the classroom. Allow a few moments for discussion. Give the pupils choices such as 10lbs., 50lbs., 100lbs., and 500lbs. Tell the pupils that an average classroom (approximately 20x30x10 feet) contains about 500 lbs. of air.

5. Point out that the weight of all the air above the earth is pushing against the earth and in all directions.

6. Fill a large test tube with water. Cover the mouth of the test tube with a small piece of paper. Hold the paper in place and invert the test tube. Ask the pupils what is keeping the paper and water from falling. Elicit that air is pushing against the paper. Hold the test tube in various positions. Point out or elicit that air is pushing from all directions. Elicit that the push of air is called pressure.

7. You may use the classic demonstration where air is used to crush a gallon tin. This is accomplished by placing about 1/8 inch of water in a gallon tin. Gently heat until steam comes out of the open end. Caution - the spout must be open since the steam pressure building up in a closed container would cause a violent explosion. After you stop heating close the cap or spout and have the pupils observe what happens.

SUMMARY:

Review the ideas developed in this lesson by eliciting what experiments or demonstrations were performed to show that air occupied space, that air had weight, and that air exerted a pressure. Encourage pupils to explain in their own way how they could plan an experiment which might show that air had weight. Relate the ideas of this lesson to the air pressure needs of tunnel builders and divers.

HOMEWORK:

1. What things do you know depend on air pressure? (Hint - tires)

2. What would happen to you if you were exposed to outer space where there is no air?

3. Using a drawing, show why the paper holds the water in the test tube when it is turned upside down.

D. AIR PRESSURE

LESSON 15. Does the air in our classroom always weigh the same?

OUTCOMES:

1. Cold air is heavier than warm air.
2. Dry air is heavier than moist air.
3. Moist warm air is lighter than cold dry air.

MATERIALS:

Teacher

flask **(or test tube)**
one hole rubber stopper
glass tubing (see diagram in procedure # 2)

Pupil

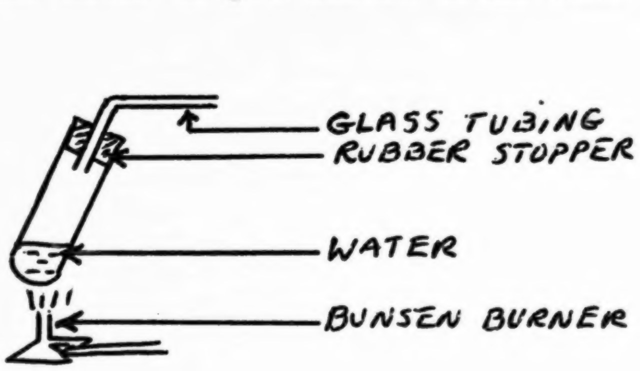
1 metal tray
1 ring stand and clamp
1 meter stick
2 coffee cans with a small hole punched in the bottom center of each
1 alcohol burner

PROCEDURE:

1. Ask the pupils to name some objects that they would expect to find in the sky throughout the year. Elicit: birds, airplanes, smoke, clouds, kites, etc. Elicit that the wind helps to keep most of these objects from falling to the earth. Point out that smoke and clouds do not need the wind or wings or engines to keep them from sinking to the earth. Try to elicit the answers to the questions:

   a. Why do clouds move?
   b. Why does smoke rise?
   c. Are clouds lighter than air?
   d. What keeps the clouds from falling out of the sky?

2. Heat the water in a flask containing a one hole rubber stopper with glass tubing bent at about a right angle. See diagram below. Note: If the water is pre-heated steam will be produced more quickly.



Caution: The glass tubing must be free of any obstructions so as to prevent a possible explosion when steam builds up pressure in the flask.

3. Point out the formation of a cloud of "steam". (Actually, vapor is not visible. The "steam cloud" is the condensate.) The pupils should note that the "cloud" rises slowly. Elicit that the "cloud of steam" is probably lighter than air. Relate this to the clouds in the sky with questions such as: "What comes from clouds?" "Where does rain come from?" to make the pupils aware that clouds contain water. Point out that the clouds are quite similar to the "steam cloud" produced in the classroom. Point out that clouds are made of water vapor. Elicit that the clouds are lighter than air. Point out or elicit the moist air is heavier than dry air (volume for volume).

4. Distribute pupil worksheets and materials. Read the directions along with the pupils. Assist the pupils with the setting up of their materials.

SUMMARY:

Discuss the results of the pupil experiment. Elicit that the container which was above the heated air rose. The pupils may recall their observations and conclusions from their experiment, to help them understand that warm air is lighter than cold air. Point out that the first balloons ever sent aloft by man were hot air balloons. (Hot air balloons were used to carry observers aloft during the Civil War.) Have the pupils recall how the "steam cloud" rose into the air. Point out that water vapor takes the place of heavier gases causing the air to become lighter. Elicit the outcomes of the lesson as follows:

1. Cold air is heavier than warm air.
2. Dry air is heavier than cold air.
3. Moist warm air is lighter than cold dry air.

HOMEWORK:

1. Find out about the hot air balloons of today and yesterday.

2. What part of your home seems to be the coolest in the summertime?

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 15. Is warm air lighter than cold air?

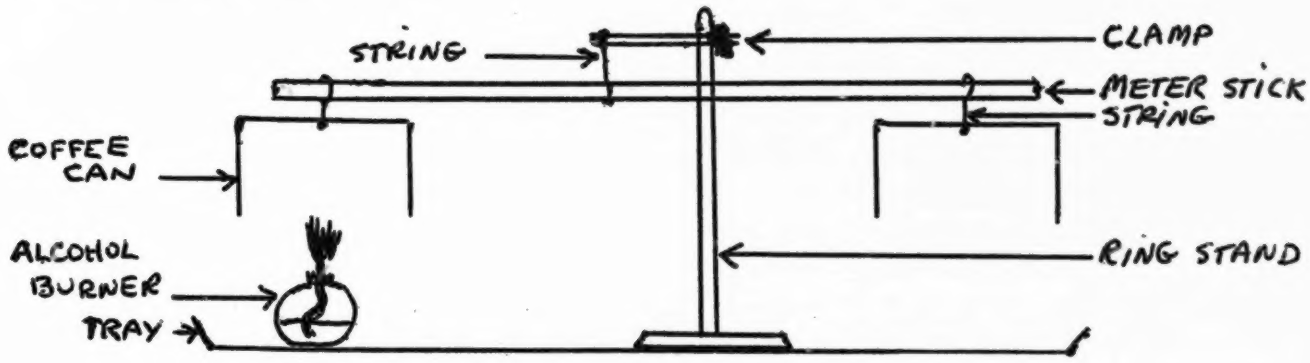
MATERIALS:

ring stand and clamp
2 coffee cans
string
alcohol burner
metal tray

PROCEDURE:

1. Set up the materials as shown below.

2. Balance the cans.


STRING
CLAMP
METER STICK
STRING
COFFEE CAN
ALCOHOL BURNER
TRAY
RING STAND

3. Light the alcohol burner.

4. The can above the flame moves (up, down) ________________________.

5. Move the alcohol burner under the other can.

6. The can above the flame moves (up, down) ________________________.

7. The flame heats the air around it. The warm air (rises, sinks) ________________________.

8. Since warm air (rises, sinks) ________________________ then cold air should (rise, sink) ________________________.

9. Which would be lighter (a) a gallon tin can filled with cold air or (b) a gallon tin can filled with warm air? ____________________.

D. AIR PRESSURE

LESSON 16. How can we "weigh" all the air above the earth?

OUTCOMES:

1. The weight of all the air above the earth exerts pressure on the ground.
2. Instruments that measure pressure are called barometers.
3. The mercury barometer contains a liquid.
4. The aneroid barometer has no liquid in it.

MATERIALS:

Teacher

tall cylinder (about 12" - 15")
1 battery jar
1 glass plate
1 small piece of oak tag (about 3" x 3")
1 barometer demonstration set-up (liquid)
1 aneroid barometer
1 barograph

Pupils

1 bottle with one hole rubber stopper and bent glass tubing as shown in pupil worksheet
1 medicine dropper
1 small aquarium
1 rubber sheet large enough to cover the aquarium
tinted water
string (about 3 feet)

PROCEDURE:

1. Fill a tall glass cylinder with tinted water. Place a glass plate over the opening. Hold the glass plate in place and invert the cylinder. Place the inverted cylinder into a battery jar filled about halfway with water. Remove the glass plate. Ask the pupils to think about the question, "What holds the water up in the large glass tube?" Allow a few moments for discussion. Lead them to see that air pressing down on the water in the jar keeps the water in the cylinder in place.

2. Place the glass plate beneath the cylinder. Remove the cylinder. Turn it right side up. Remove the glass plate. Place the oak tag over the cylinder opening. Invert the cylinder, be sure to hold the card in place. Hold the cylinder above the battery jar. Remove your hand from the card. Air pressure should hold the card in place and support the water pushing against it. Ask the pupils to explain what they observe. Elicit that air pressure holds the water in the cylinder. Draw this demonstration on the board.

Place arrows indicating the opposing pressures working in this demonstration.

3. Show the pupils a demonstration mercury barometer. Ask them to measure the height of the mercury column - use a yardstick or meter stick. Have the pupils observe the space above the mercury column. Ask them what is in there. Point out, after a brief discussion, that the space is empty. Elicit the word vacuum as a substitute for empty. Have the pupils make a simple drawing of the barometer. Labels should include - air pressure, vacuum, height in inches, mercury, and glass tube.

4. Distribute pupil worksheets and materials. Read and discuss the worksheet with the pupils. Discuss the results of their experiment. Elicit that changes in pressure cause the liquid to move. After the pupils complete their activity show them the aneroid barometer and the barograph. Point out the "metal cans" which are the "active" parts of these barometers. If time permits discuss the use of the aneroid barometer as a height indicator (altimeter).

SUMMARY:

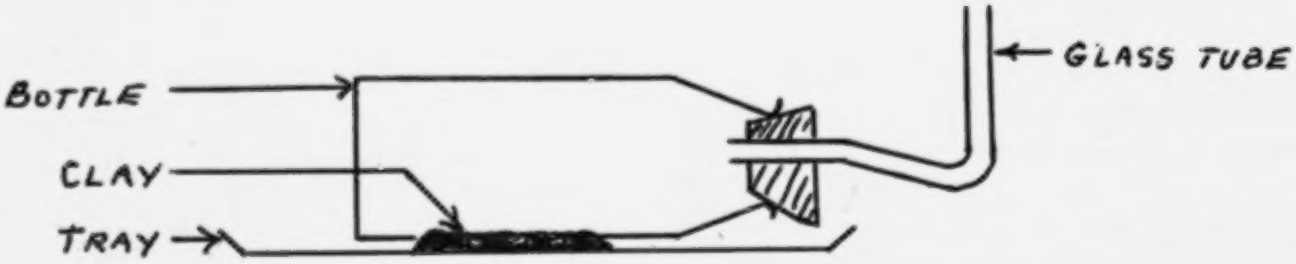
Have the pupils recall how air pressure can support a liquid in a closed tube. Elicit that air pressure is the result of all the air above the earth pressing against the earth. Elicit the types of barometers used to measure air pressure. Have the pupils recall the height of the column of mercury.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 16. How does a barometer work?

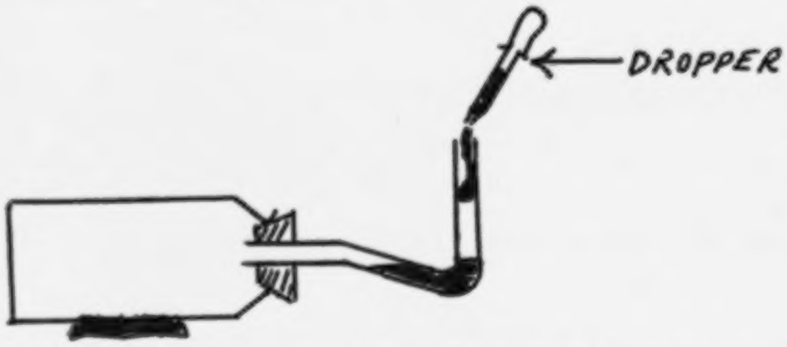
PROCEDURE:

1. Look at the drawing below. This is a homemade barometer. On your tray is the same barometer. Place it on a piece of clay so that the thin glass tube points up - see the drawing.

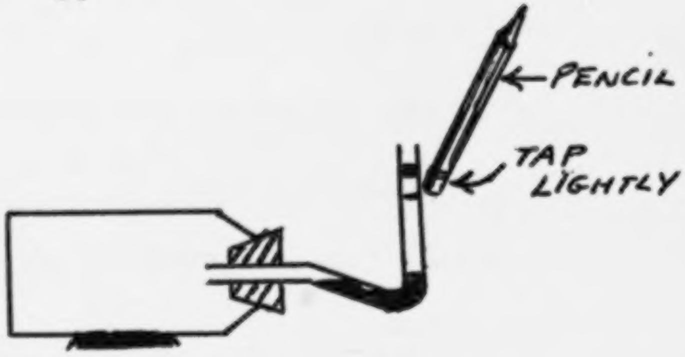

GLASS TUBE
BOTTLE
CLAY
TRAY

2. Use the dropper to drop a small amount of liquid into the glass tube. Very gently tap the glass tube with a pencil. This helps the water to move down - see the drawings below.

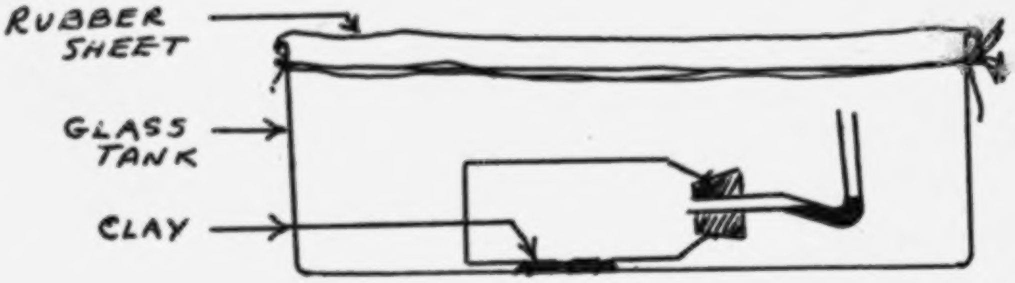
a.



b.


PENCIL
TAP LIGHTLY

3. Place the bottle inside the large glass tank. Cover the tank with a rubber sheet. Tie the sheet in place - see diagram below.


RUBBER SHEET
GLASS TANK
CLAY

4. Push the rubber sheet in about one inch. Look at the level of the water in the glass tube. Do this one more time.

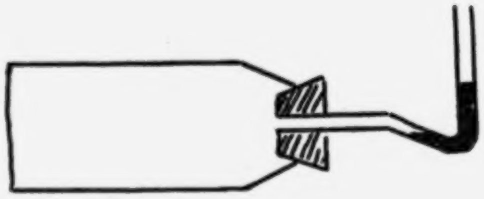
a. When the sheet was pushed in the water moved (up, down) ________.

b. When we took our hand off the sheet the water went (up, down) ________.

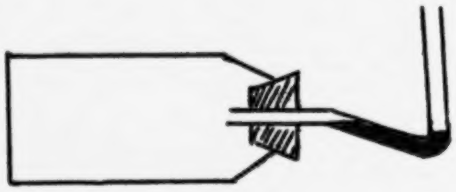
c. When we push the sheet down the air pressure in the large glass tank becomes (more, less) ____________________.

5. Study the diagrams and answer the questions.

A.



B.



a. The water in (A, B) _________ is lower than the water in the other bottle.

b. The weight of air pushing down is greater on (A, B) _________ than (A, B) ___________.

c. As the air pressure changes the water will move ___________ or _____________.

d. Very light air is over bottle (A, B) ______________.

E. WEATHER

LESSON 17. How does weather get into the air?

OUTCOMES:

1. An air mass is formed when air stays over a particular part of the earth for a long time.
2. The air mass picks up the temperature and moisture of the particular part of the earth it is over.
3. Air masses will move from place to place.
4. Air masses bring weather changes to areas they pass over.

MATERIALS:

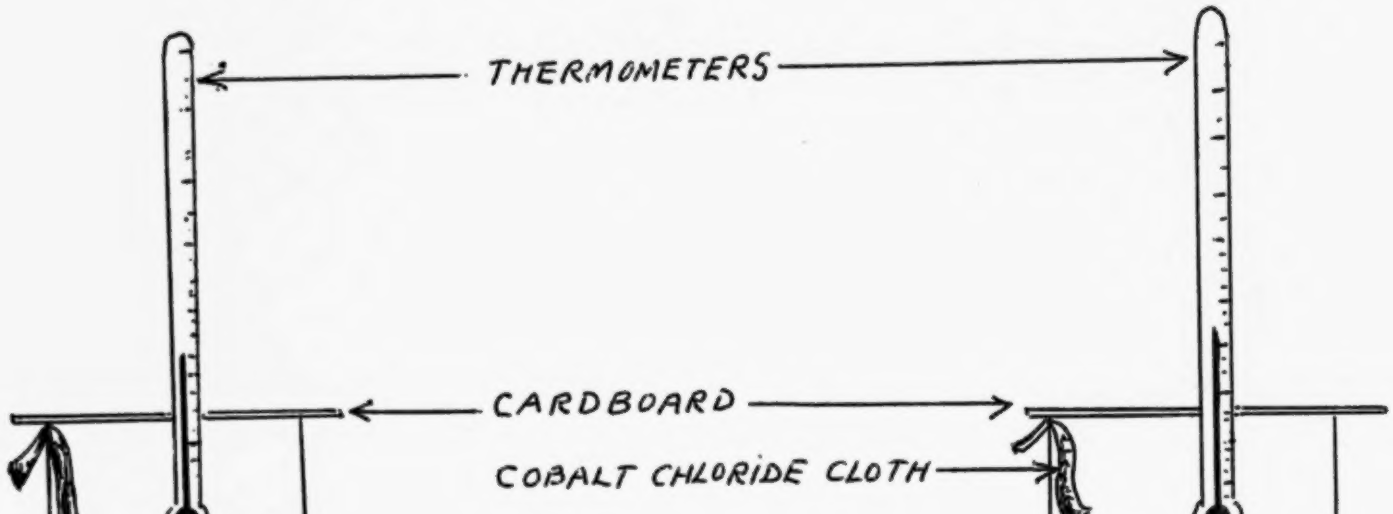
2 thermometers
2 beakers
ice cubes
warm water
2 strips of cloth treated with cobalt chloride
cardboard

PROCEDURE:

In this lesson you will perform the actual demonstration while the pupils will note and record their observations on the worksheet.

1. Distribute the pupil worksheets so that the pupils can answer the questions.

2. Set up the materials as shown in the diagram.



Place the thermometers through holes in the cardboard so they will stand up.

Note: The warm water can be obtained from the warm water faucet.

3. Air masses are formed over land as well as over water. There are 4 main types of air masses depending on where the mass is formed.

SUMMARY:

Air masses take on the temperature and the humidity of the area over which they form. These air masses can move. They bring different weather conditions to the place they pass over.

HOMEWORK:

1. If an air mass from Canada passed over New York City what type of weather do you think we would have?
2. If an air mass from the Gulf of Mexico passed over New York City what type of weather do you think we would have?

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 17. How does weather get into the air?

A. Answer these questions from the demonstration being performed in the front of the room.

1. Before the teacher set up the materials in the demonstration, the thermometer reading was ___________________.

2. The temperature in the beaker with warm water went (up,down) __________________ as shown by reading the thermometer.

3. This means the air in this beaker became (warmer, colder) __________________.

4. The cloth turned (blue, pink) _________________.

   Note: The cloth will turn pink when wet and blue when dry.

5. The air in this beaker is (dry, wet) ____________and (warm, cold) _______________.

6. The temperature in the beaker with ice cubes went (up, down) _______________.

7. This means the air in this beaker became (warmer, colder) _______________.

8. The cloth turned (blue, pink) _____________ compared to the cloth in the other beaker.

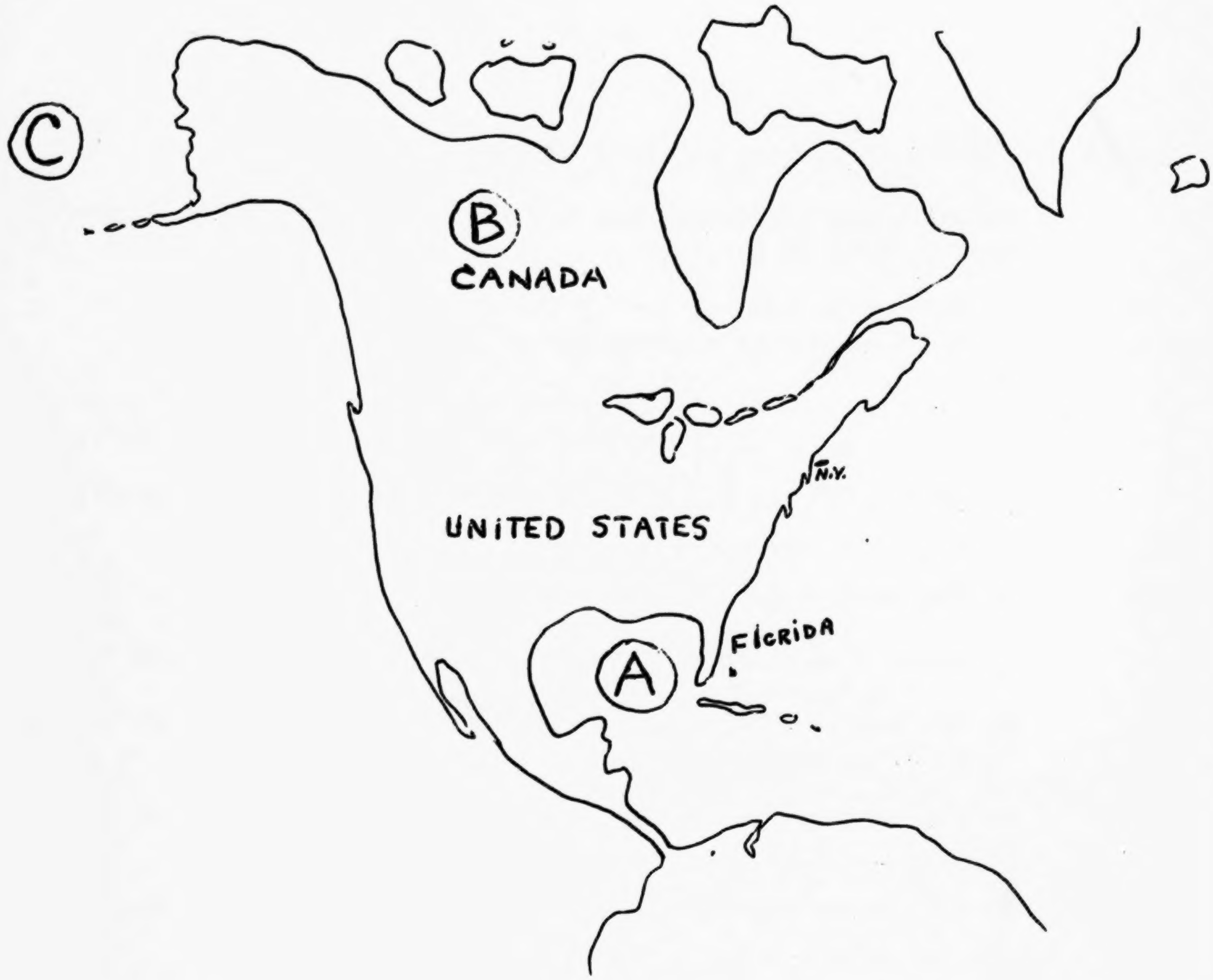
9. The air in this beaker is (dry, wet) _______________ and (warm, cold) _______________.

10. The air in the beaker with the ice cubes became cold because of the _______________.

11. The air in the beaker with the water became warm because of _________________.

    Remember: Air picks up the temperature and humidity of what is under it.

B.


C
B
CANADA
N.Y.
UNITED STATES
FLORIDA
A

A, B, and C are places under different air masses. Place a check in the column that applies to the air mass. Remember, air masses take on the temperature and humidity of the places over which they form.

	WARM	COLD	DRY	WET
A				
B				
C				

E. WEATHER

LESSON 18. What happens when two air masses meet?

OUTCOMES:

1. The boundary between two air masses is called a front.
2. When a mass of cold air moves in and pushes warm air up, a cold front is formed.
3. When a mass of warm air moves in and rises over cold air a warm front is formed.

MATERIALS:

Teacher

large clear jug or bottle
rubber stopper
heavy motor oil
blue ink
2 thermometers

Pupil

black, red, and blue crayons

PROCEDURE:

1. Begin the lesson by drawing on pupil experiences in asking a question such as,"Where do you think it is warmer, near the ceiling or near the floor?" Guide the pupils to realize that the warm air rises and cooler air settles to the floor (recall the "convection box" demonstration). Ask pupils to consider how they could prove this conclusion . If time permits, allow a pupil to read the temperature on a thermometer held aloft while standing on the table or desk while another reads the temperature on a thermometer held near the floor. Allow time for the temperatures to reach proper points.

2. Use the following demonstration to show the formation of fronts. Half fill a flat bottle (a gallon jug is good) with water which is colored with blue ink. Let this represent a cold mass. Fill the rest of the bottle with a heavy motor oil which represents a warm air mass and cork the bottle. Tip the bottle to show the pupils that the oil (warm air) floats on top of the water (cold air). Elicit that there is a boundary line between the two liquids (air masses) which is called a front.

SUMMARY:

A front is a boundary between two air masses. The warmer air will be over the colder air in a front because it is pushed up by the colder air.

HOMEWORK:

1. A short storm is usually the sign of a (warm, cold) __________ front.
2. Explain why this is true (refer to your pupil worksheet to answer this question).

REFERENCE:

The General Science Handbook - part 3, Bureau of Secondary Curriculum Development, New York State Education Department, 1956. pages 164, 165.

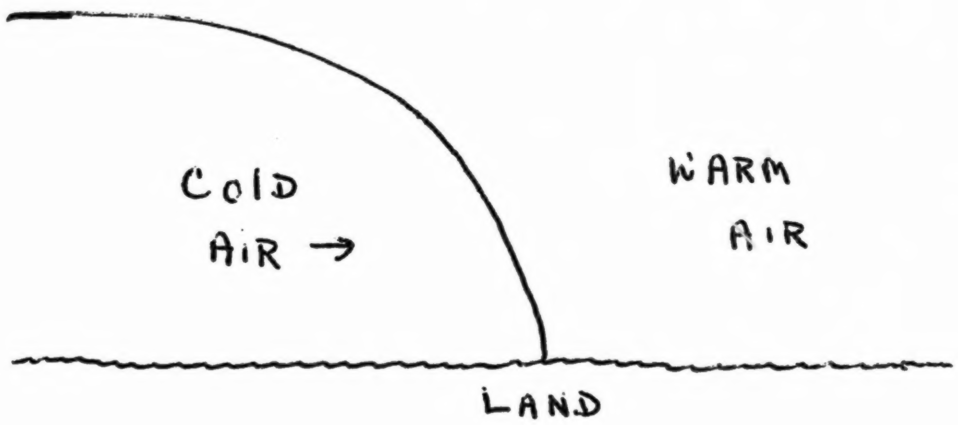
PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 18. What happens when two air masses meed?

MATERIALS:

black, red, and blue crayons

1. COLD FRONT (Cross Section)



In a cold front, cold air moves in and pushes the warm air over it. If the warm air is moist many clouds will form in a small area. Heavy rain or snow will fall and it will be followed by cold, clear weather.

a. Color the cold air blue and the warm air red.

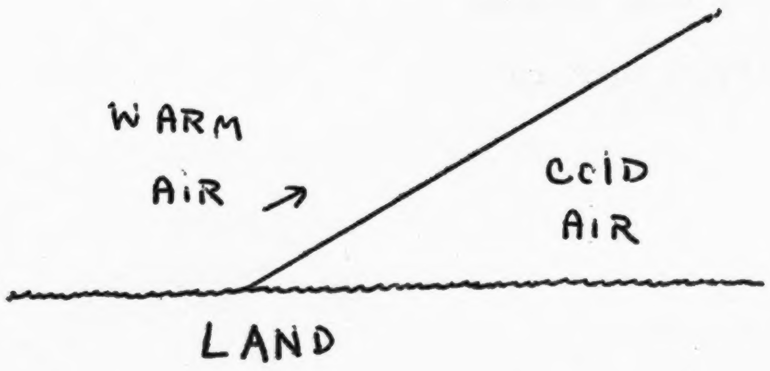
b. Draw a black line to show where the front is.

c. Draw an arrow to show which way the warm air is going.

d. Draw pictures of clouds in the place they are most likely to be found.

e. Why did you pick this place for the clouds?

2. WARM FRONT (Cross Section)



In a warm front, warm air moves in and over a mass of cold air. The warm air slides slowly over the cold air and therefore forms clouds over a long distance.

a. Color the cold air blue and the warm air red.

b. Draw a black line to show where the front is.

c. Draw pictures of clouds where you think they would be found.

d. Storms are usually short and violent in a (cold, warm) ________ front.

e. Storms usually last long, but are mild in a (cold, warm) ______ front.

E. WEATHER

LESSON 19. How do we make a picture of what the weather is like?

OUTCOMES:

1. Weather stations are located all over our country.
2. These stations send their observations to the United States Weather Bureau every 6 hours.
3. Their observations include wind speed, wind direction, temperature, pressure, barometer readings, etc.
4. This information is forwarded to all weather stations so that the local weather man can make predictions about future weather coming to that area.

MATERIALS:

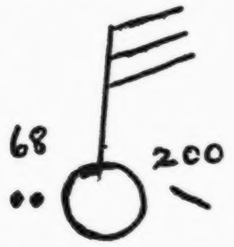
Teacher

chart of a station model

PROCEDURE:

1. Distribute the worksheets and do part 1 of the worksheet along with the pupils.

2. Show the chart of a station model. If none is available, draw the picture below on the board and explain each of the items on the picture. See worksheet. Review part 1 by asking the pupils to give the wind speed and direction in the picture. Is it a clear or a cloudy day?



68 = temperature
200 = pressure
\ = pressure falling (/= pressure rising)
(—= pressure steady)
•• = rain (** = snow)

Optional : You may wish to show other items on the station model, such as, past weather, type clouds, dew points, amount of percipitation, etc. If so, the symbols can be found in the science textbook.

3. Have the pupils do part 2 of the worksheet by themselves while you walk around the room. Guide them in their work.

SUMMARY:

Weather stations all over the world find the temperature, pressure, and other information in their area. This is sent to the United States Weather Bureau where it is plotted on a map in shorthand (station model).

HOMEWORK:

1. Complete part 2 of the worksheet at home.
2. Bring in a weather map from the New York Times.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 19. What is the job of a weatherman?

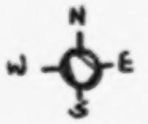
PROCEDURE:

1. Complete the following:

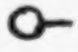
a. ○ This is the station on a clear day.

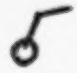
● This is the station on a completely cloudy day.

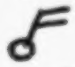
◓ This is the station on a (clear, cloudy, half cloudy) ____________________ day.

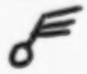
b. 

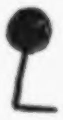
The wind is coming from the north.


The wind is coming from the (west, east) ________.

c. 
The wind's speed is about 10 miles an hour.


The wind's speed is about 20 miles an hour.


The wind's speed is about (20, 30, 40,) __________ an hour.

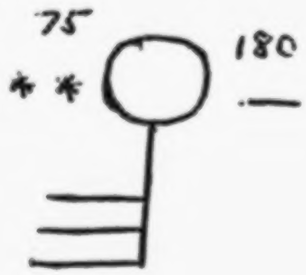
d. 
This station is (clear, cloudy) ______.

The wind is coming from the (north, south) __________.

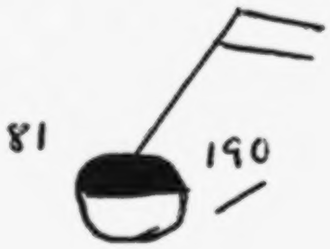
Its speed is (10,20) __________ miles an hour.

2. In the table below, write down all the weather information for the following station models.

a.



b.



	Station A	Station B
Temperature		
Pressure		
Pressure Change		
Sky (clear or cloudy)		
Wind Speed		
Wind Direction		

ATMOSPHERE, WEATHER, AND OCEANS

E. WEATHER

LESSON 20. High or Low? How does the weatherman know?

OUTCOMES:

1. Lines connecting points of equal pressure on a weather map are called isobars.
2. These isobars show us high and low pressure areas.
3. Low pressure areas are more likely to give precipitation.

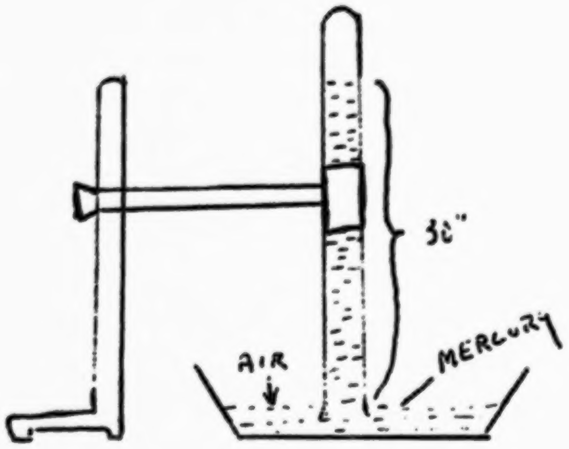
MATERIALS:

Teacher

stand
mercury
36" glass tube
glass trough
ruler

PROCEDURE:

1. Fill a long glass tube with mercury, turn it upside down with your finger on the opening and place it in a glass trough. Most of the mercury will stay in the tube due to the pressure of the air on the dish. Have a pupil measure the height of the mercury. It is about 30". Refer the pupils to a previous lesson in which they measured the height of the mercury. What does the 30" represent? Air pressure is also shown on weather maps. These maps have lines on them which connect places of equal pressure. These lines are called isobars. However, instead of using inches to measure pressure, weathermen use millibars (30 inches is about 1014 millibars).



2. Elicit from the pupils that a high pressure area is one in which there is little percipitation. The water vapor would have a difficult time rising due to the air pushing down. In a low pressure area we would expect precipitation because more water vapor can rise and form clouds.

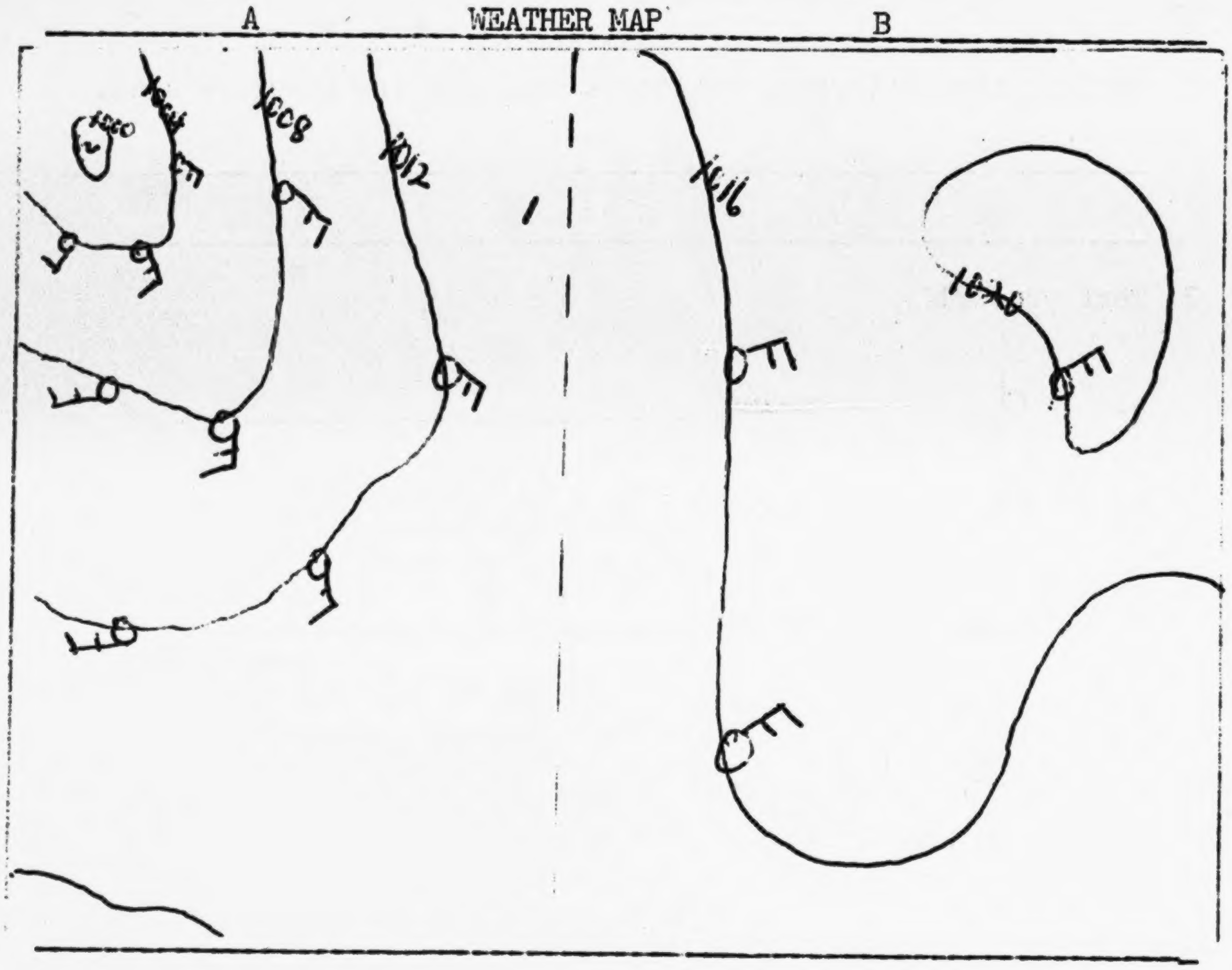
3. Enforce the importance of the words High and Low on weather forecasts. Explain that high and low pressure areas can cover hundreds of miles.

4. Distribute the pupil worksheets and do each question with the class. Have them read the questions aloud and elicit an explanation of their answers.

PUPIL WORKSHEETS
(MAY BE DUPLICATED FOR PUPILS)

LESSON 20. High or Low? How does the weatherman know?

Bellow is a picture of a weather map. The numbers represent the pressure in millibars. From what you have learned, try to answer the questions below the map.



1. The small circles represent weather (balloons, stations) ____________.

2. The lines attached to the circles represent (wind direction, clouds)

____________________.

3. Look at the numbers on the isobars. They get (lower, higher) __________

as we go from 1 to 2.

4. Side A is a (high, low) ____________ pressure area.

5. The numbers of the isobars get (higher, lower) ______________ as they go to side B.

6. This is a (high, low) _______________ pressure area.

7. The wind is blowing (away, towards) _____________ the center of the pressure area.

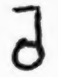
HOMEWORK:

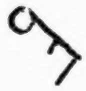
1. Explain the difference between a high and low pressure area.

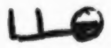
____

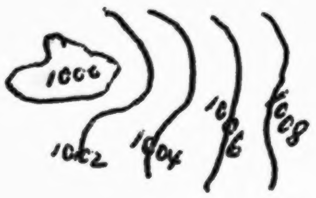
____

2. Test yourself:

a.  means ___________________________

b.  means ___________________________

c.  means ___________________________

d. 

means _________________

E. WEATHER

LESSON 21. How can we forecast the weather?

OUTCOMES:

1. Weather is the condition of the atmosphere at a certain time.
2. To obtain information about the weather, we use weather vanes, anemometers, barometers, thermometers, and other instruments.
3. We can get an idea of the weather that will be coming to us by:

   a. looking at the United States weather map to find out the weather around us
   b. determining the wind speed and direction to find out which weather will pass over us and how soon
   c. looking at our barometer to see if a high or low pressure area is over us

MATERIALS:

Teacher

wind vane
anemometer
barometer
thermometer
hygrometer
rain gauge

PROCEDURE:

1. As a motivation, display all of the materials on the desk and tell the class that this is a make believe weather station. Review all of the weather instruments by having pupils come to the front of the room to explain what each instrument does.

2. Set up a situation in which your make believe weather station has the following information;

   pressure = falling
   wind speed = 20 miles per hour
   wind direction = south
   temperature = 70 degrees
   humidity = 82%
   Raining

   Make sure the class understands that wind direction means the direction the wind is coming from. Therefore, the wind is coming from the south and heading north. To dramatize this tell the following story.

If your friend lived 100 miles north of you, how long would it take the weather near you to reach him? Remember - the wind speed is 20 miles an hour. Wouldn't it be nice if you could tell him it will rain in 5 hours? He would be able to plan his day according to the weather.

3. Our weather is forecast similar to the make believe situation. Of course we can't call each place in the United States to tell them the weather. Instead, every 6 hours a United States Weather Map is published giving us the weather picture for the United States. Then, the weather bureau of each state determines which weather will reach their state and when it will come.

4. Distribute the pupil worksheets. Walk around the room while the pupils are working to make sure they know what to do. Review the pupil worksheets towards the end of the period.

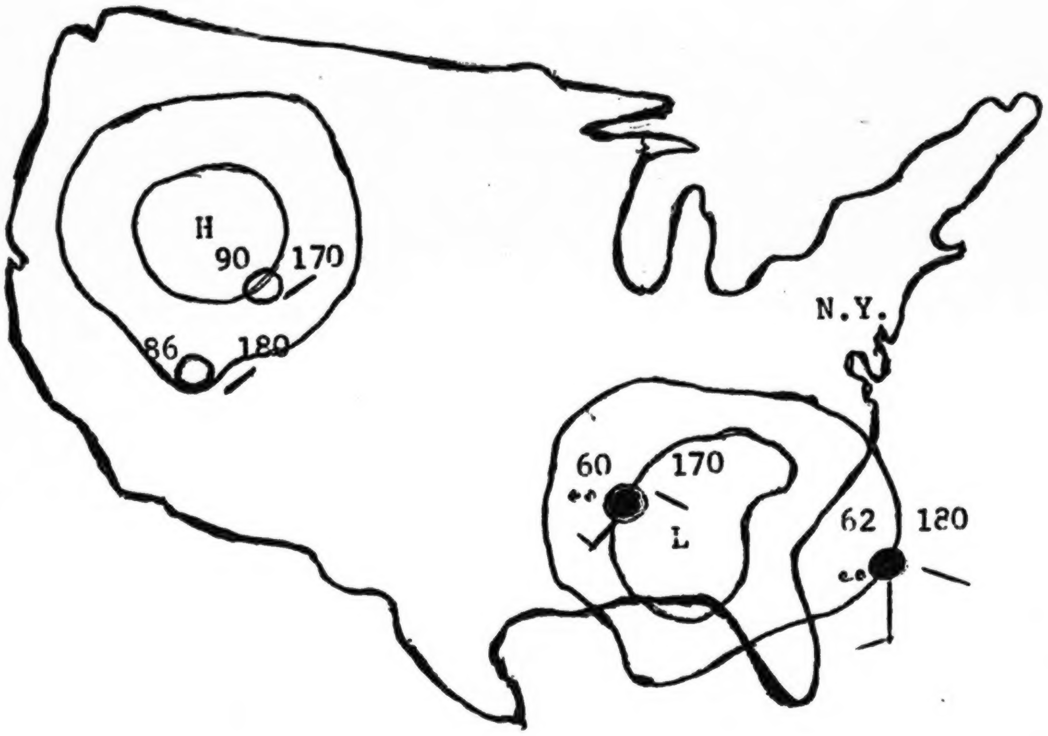
SUMMARY:

We can tell the weather that will reach us by learning about the pressure areas, the wind speeds, and wind directions of our surrounding areas.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 21. How can we forecast the weather?

Study the map below. Forecast tomorrow's weather for New York City by answering the questions below.



1. The H stands for (high, low) ______________ pressure.
2. Look at the direction of the wind in each pressure area.

   The (high, low) ___________ pressure area is heading for New York City.
3. In the pressure area heading for New York City the wind is coming

   from the (north, south, east, west) _______________.
4. The wind speed is about (5, 10, 20, 30) ____________ miles per hour.

5. The temperature in New York City will be about (20, 40, 60, 90)

__________ degrees.

6. It will be (clear, cloudy) ________________.

7. The barometer is (rising, falling) _____________.

8. New York City will have (rain, snow, sleet) __________________.

E. WEATHER

LESSON 22. How can a cloud produce electricity?

OUTCOMES:

1. Thunderstorms are accompanied by lightning and thunder.
2. Lightning is the same as electricity.
3. Thunder is the noise caused by lightning.
4. Lightning is attracted to the closest point.

MATERIALS:

Teacher

induction coil
dry cells
wire
paper

Pupil

wood splint
miniature lamp socket
$1\frac{1}{2}$ volt bulb
wires
dry cell
metal strip

PROCEDURE:

1. Ask the pupils to rub their feet on the floor, stand up and touch a metal object. "Did you feel a shock? What caused it?"

   Note: The above demonstration will work best on a dry day. If it does not work, elicit from pupil experiences that rubbing causes static electricity. Examples are walking on a carpet and touching a door knob, rubbing a comb through your hair and seeing a spark, etc.

2. Refer to the kite experiment by Benjamin Franklin in which he discovered that lightning is the same as electricity. Clouds make static electricity on the top portion and spread out due to moving air within the cloud. This causes friction between water droplets and small ice crystals. Friction, as we know from our personal experiences, can produce electricity. When clouds produce electricity, it is called lightning.

3. Distribute the pupil worksheets. Explain that a demonstration will be performed in front of the room which the pupils must watch before completing their worksheets.

4. Demonstrate an induction coil with a copper wire attached to each top screw of the secondary coil 14-1398. Imagine the coil to be a cloud. The spark would be the lightning while the noise represents thunder.

5. Thunder is produced because of the tremendous heat given off by the lightning. To demonstrate this, touch the spark given off by the coil with a piece of paper. The paper will burn. This heat causes the air to expand very quickly and thus we get thunder. The same thing happens when a jet plane goes very fast. The air expands and causes a sonic boom.

SUMMARY:

Lightning is caused by friction in a cloud between water droplets and ice crystals. Thunder is a noise caused when air expands quickly due to the heat from the lightning.

HOMEWORK:

See bonus question at end of worksheet.

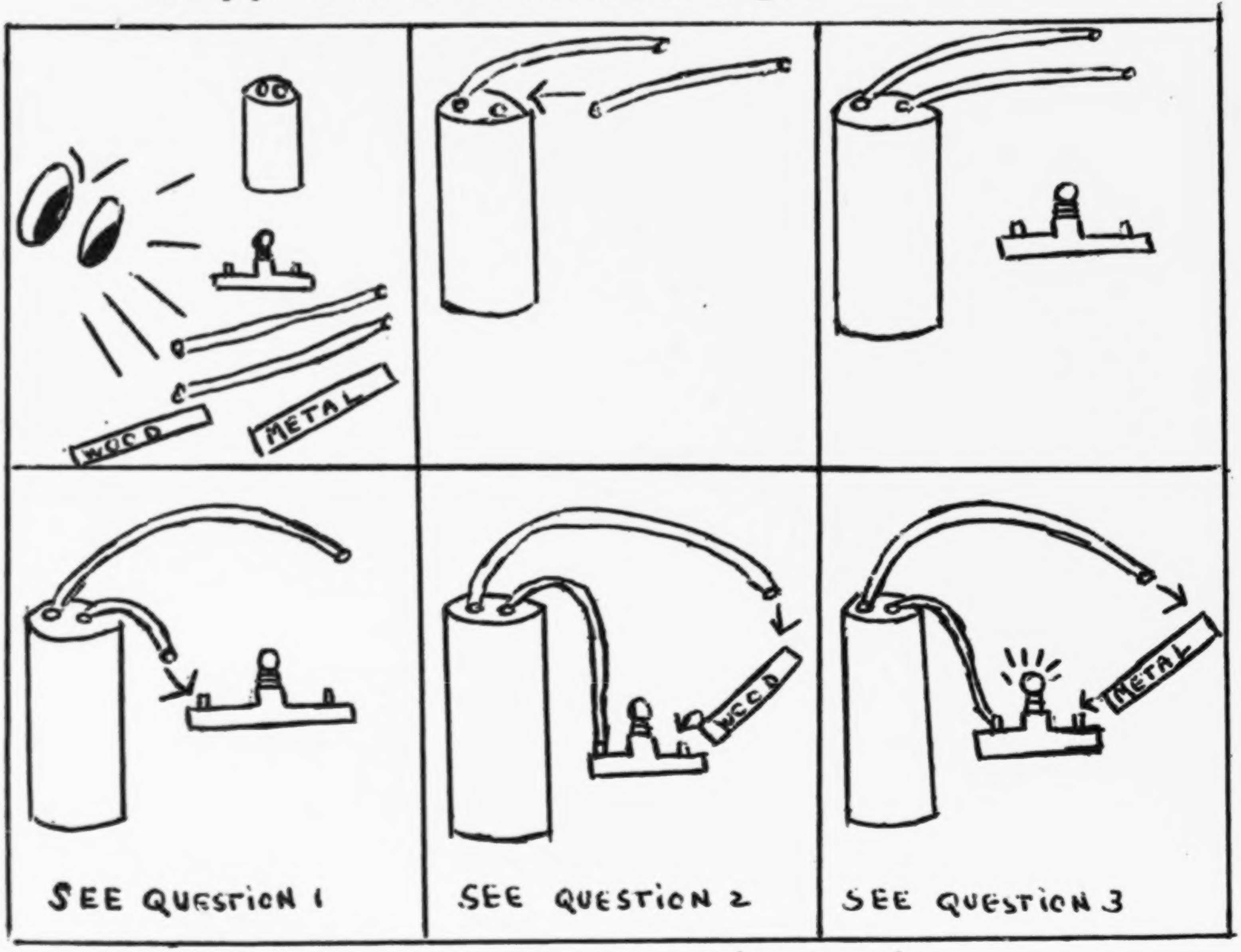
PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 22. How can we be safe during a thunderstorm?

MATERIALS:

miniature lamp socket
$1\frac{1}{2}$ volt bulb
2 wires (1 alligator clip on one of the wires)
dry cell
wood splint
metal strip

Set up your materials as shown in the diagram.


WOOD
METAL
WOOD
METAL
SEE QUESTION 1
SEE QUESTION 2
SEE QUESTION 3

1. The light bulb doesn't work because it (is, is not) ______________ connected.

2. Touch one end of a wood splint to the lamp socket and other end to the alligator clip. The bulb (does, does not) ______________ light.

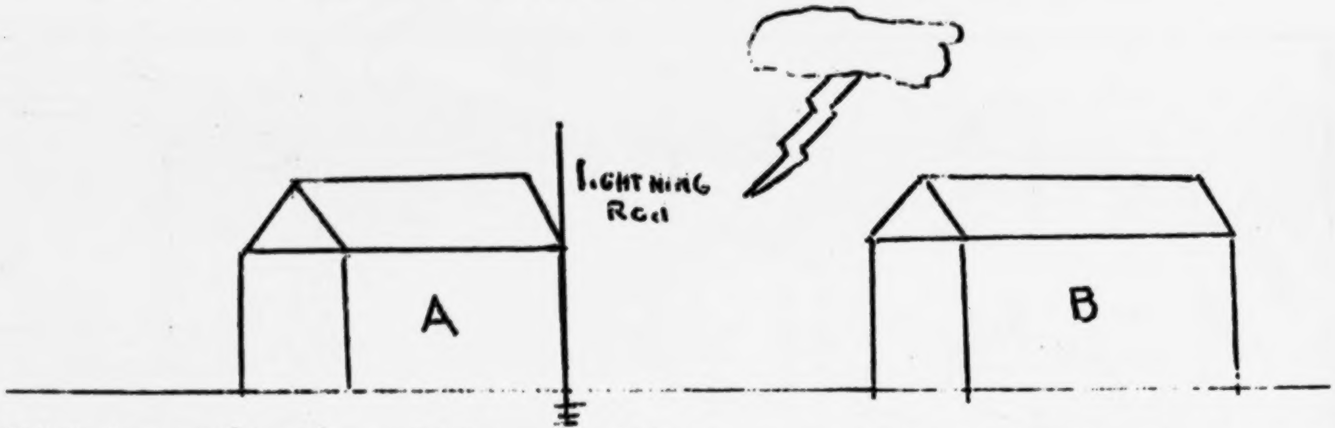
3. Touch one end of a metal strip to the lamp socket and the other end to the dry cell. The bulb (does, does not) ____________________ light.

4. This experiment shows us that metals let electricity travel through them easily.

BONUS QUESTION:

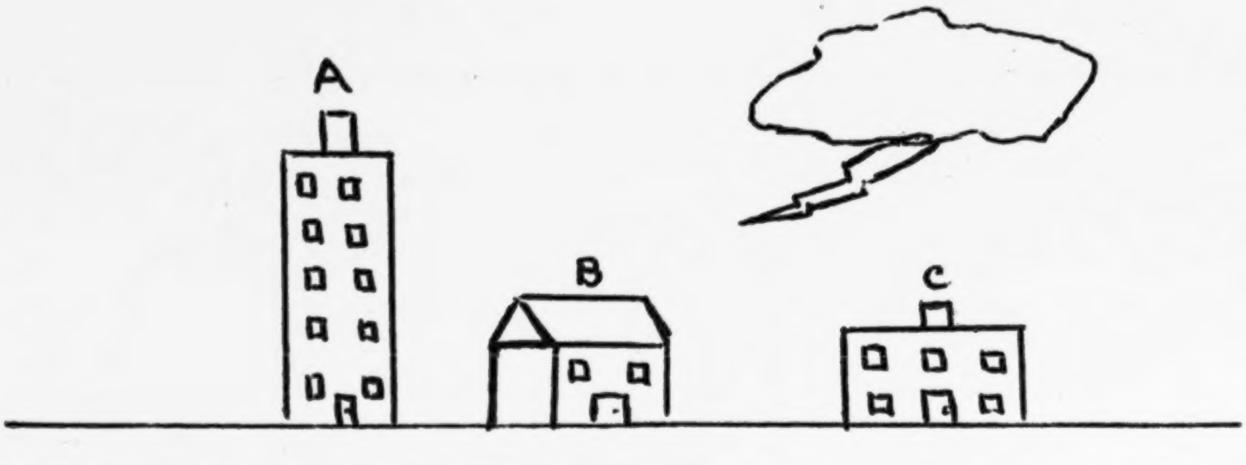
Benjamin Franklin knew this and invented a lightning rod which attracts and carries electricity away from a building and into the ground so it does no harm. He also knew that lightning usually hits the closest thing to it. Try to answer the following questions about thunderstorms from what you have learned in class.

1.



Which house (A, B) would be most likely to be hit by lightning?

2.



Which house (A, B, C) is most likely to be hit by lightning? Why?

E. WEATHER

LESSON 23. How does our weather affect air pollution?

OUTCOMES:

1. Most of our air pollution comes from the incomplete burning of fuels. This occurs in car exhausts, chimneys, etc.
2. Carbon monoxide, sulfur dioxide, and amonia are some of the gases in the air which cause pollution.
3. Sometimes cool air near the earth is trapped by a layer of warmer air.
4. When this occurs, the gases formed due to incomplete burning are trapped in the cool air and cause pollution.

MATERIALS:

Teacher

2 beakers
paper
matches
glass plate

Pupils

metal tray
2 pyrex beakers
alcohol burner
matches
smoke paper
beaker tongs

PROCEDURE:

1. As a motivation, discuss some of the effects of air pollution on humans.

   a. People with respiratory trouble have difficulty breathing. Stress health hazards.
   b. City Hall in New York City had to be refaced because its marble corroded due to the chemicals in the air.
   c. Manufactures of nylon stockings had to make them stronger because of the chemicals in the air.

2. Place a small piece of burning paper into a small beaker. It burns until an ash is left. Not too much smoke is found. Do the same thing in another beaker, but cover it with a glass plate. The fire goes out before the paper is completely burned. Heavy smoke will be seen in the beaker.

3. Distribute the pupil worksheets and materials. Be sure to observe each group doing the experiment to avoid accidents.

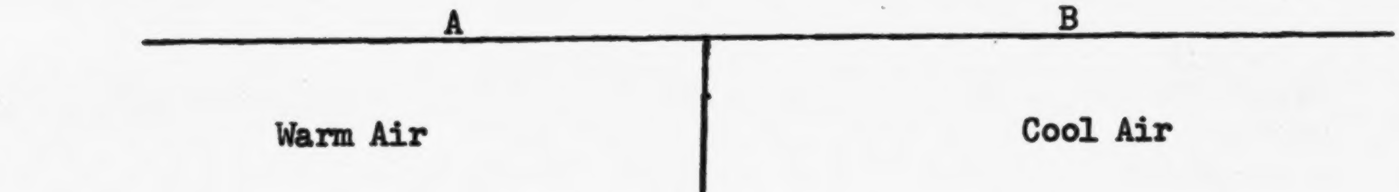
SUMMARY:

Incomplete burning produces smoke and gases which cause air pollution. Stress that air pollution is injurious to our health. Point out that air may become polluted at anytime when excess incompletely burned products are thrown into the air. However, the weather conditions described in this lesson may add to the problem by trapping the pollutents, as for example, the heavy smog in Los Angeles.

HOMEWORK:

1. Air pollution is most likely to occur in (A or B) _________.

2. Why? ____.



PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 23. How does weather affect air pollution?

MATERIALS:

metal tray
2 pyrex beakers
alcohol burner
smoke paper
beaker tongs

PROCEDURE:

1. Tear the smoke paper in half. Place one half on a metal tray. Light it. Place the mouth of a beaker about 4 inches away from the paper and directly over it.

   a. The air in the beaker has (the same, a different) ____________ temperature than the air outside the beaker.

   b. The smoke (did, did not) ________________ go into the beaker.

   c. If the air near the earth had almost the same temperature as you go up, there (would, would not) ______________________ be air pollution.

2. Turn a pyrex beaker upside down and place it over a lit alcohol burner for about 2 minutes. Hold it with the beaker tongs. Now do the same as in step A using the other half of the smoke paper.

   a. The air in the beaker is (warmer, colder) __________________ than the air below it.

   b. The smoke (did, did not) _______________ go into the beaker.

   c. If warm air is above cool air, smoke and other gases in the cool air (can, can not) __________________ get out.

   Remember : When warm air traps cooler air below it, the gases from incomplete burning stay in the cooler air and can't get out. This causes air pollution.

F. THE OCEANS

LESSON 24. Why can't we drink ocean water?

OUTCOMES:

1. About 3% of the ocean water is salty.
2. Most of the salt in the oceans is NaCl (table salt).
3. It is easier to float in salt water.
4. Salt can be separated from water by evaporating the water.

MATERIALS:

Teacher

2 beakers one containing fresh water; the other containing a saturated salt solution
1 density bottle or other device which will float in salt water and sink in fresh water

Pupil

1 small beaker of clean distilled water or tap water (about ½")
1 sample of halite or rock salt (NaCl)
1 glass rod or spoon
1 test tube
1 test tube holder
1 alcohol lamp
1 metal tray

PROCEDURE:

1. Show the class the two large beakers of water. Place the density bottle in the salt water beaker. (It should float.) Remove the density bottle, rinse, and place it in the fresh water beaker. Allow the class a few minutes to discuss the strange behavior of the bottle. Repeat the demonstration. Ask the pupils to suggest means of finding out why the bottle behaves as it does. Allow one or two pupils to study the liquids closely. Point out that the liquids are water but one is different from the other. A pupil may taste the water by touching it with his fingertips and placing these against his lips. He should note that one of the liquids has a salty taste. Ask the pupils which of the two beakers of water he would prefer to drink. Elicit, the one with the fresh water.

2. Ask the pupils what find of food makes them thirsty. Elicit salted food. Point out that we do not drink sea water because our bodies can not absorb it. Discuss the pupils' experiences with trying to float in fresh water and ocean water. Point out that it is easier to float in the ocean (discounting, of course, the effect of waves and breakers). Tell the pupils about Great Salt Lake in Utah. Point out that it is very easy to lie on your back and read a newspaper while floating in this lake.

3. Distribute pupil materials and worksheets. Read the directions along with the pupils. Show the pupils the correct technique in using a test tube holder and the proper method for heating a liquid in a test tube.

SUMMARY:

Discuss the results of the pupil activities. Elicit that the oceans got salty by dissolving salt out of the rocks in the earth. Point out, that in some places in the world, salt is "mined" this way. Have the pupils point out that salt water cannot be used for drinking water. Elicit that fresh water can be obtained from salt water by evaporating the water. You may briefly discuss methods used by sailors to change sea water into drinking water. Have the pupils recall that a very small percentage - about 3% - of sea water is made up of various salts. Elicit that table salt (NaCl) is the most common salt in the oceans' waters.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 24. How did the oceans get salty?

MATERIALS:

small beaker of clean distilled water or tap water (about ½")
sample of halite or rock salt (NaCl)
glass rod or spoon
test tube
test tube holder
alcohol lamp
metal tray

PROCEDURE:

1. Pour a few drops of pure water into a clean test tube. Label this test tube A. Place the test tube in the test tube rack.

2. Look at the rock salt.

3. Place the rock salt in the small beaker of pure water. Stir the water with the glass rod for a few minutes.

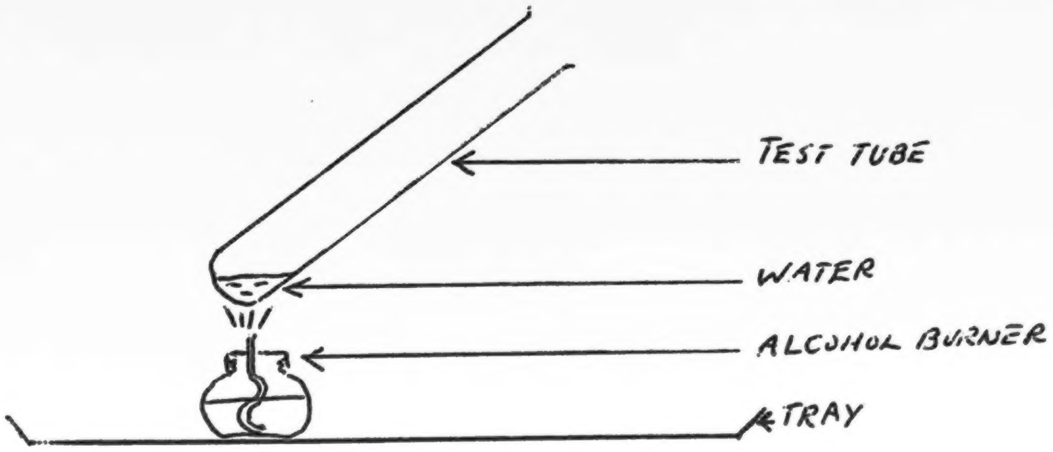
4. Remove the rock salt from the beaker.

   a. The rock salt (looks, does not look) ______________ the same.

   b. The rock salt got (smaller, bigger) ______________________.

5. Pour a few drops of the water from the beaker into a clean test tube. Label this test tube B.

6. Heat test tube B as shown below. Keep heating the test tube until all or most of the water is gone. Remove the heat.



Do not touch the hot test tube. It stays hot for a fairly long time. Place it in the test tube rack to cool.

7. Place the test tube of pure water (A) over the flame. Heat until all of the water is gone. Place the test tube in the rack.

QUESTIONS:

1. The water in both test tubes changed into (steam, smoke) __________.

2. Test tube (A, B) ________ is cleaner than the other test tube.

3. The white stuff in the test tube is most likely (chalk, powder, salt) ______________.

4. The salt in the ocean could have come from the (rocks, plants, animals) __________________ of the earth.

5. The earth's (rivers, glaciers, winds) ______________ must have carried most of the salt into the oceans.

F. OCEANS

LESSON 25. How deep is the ocean?

OUTCOMES:

1. Ocean depths can be measured by means of sound waves.
2. The depth of the oceans vary from place to place.
3. The deepest part of the Atlantic Ocean is off Puerto Rico.
4. The oceans cover nearly 3/4 of the earth's surface.
5. The ocean bottoms look somewhat like the land above water.

MATERIALS:

Teacher

tuning fork with rubber stopper attached to the base
resonance box
2 beakers
opaque projector
Life Nature Library Book, The Sea pp. 65 - 74
map of the world or a globe

Pupil

profile of the ocean floor (see pupil worksheet)

PROCEDURE:

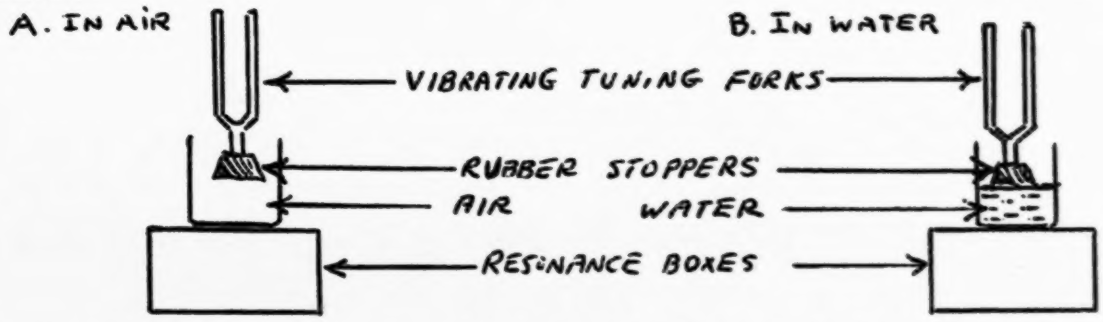
1. Discuss the fate of ships that have gone to the bottom of the ocean. Good examples are the Titanic and the Andrea Dorea (both were designed to be unsinkable). Lead the pupils to ask how far down a ship can go when it sinks. You may point out that the Andrea Dorea has been examined by Scuba divers and therefore, it is in fairly shallow water (about 250 feet). The Titanic is about 12,000 feet down.

2. Show the pupils pictures of the ocean bottoms using the book, The Sea, or any other pictures that show the same features. Have the pupils note the mountains and deep canyons or "valleys" that make up the ocean floor. Point out the shallow areas that border the continents, especially along the eastern seaboard. Elicit from the pupils that the ocean floor has many features that we find on land.

3. Have the pupils study a map or globe of the world. Ask them to guess which there is more of covering the earth, land or water. Elicit that more water covers the earth's surface than land. The pupils may attempt guesses as to how much land there is compared to water. You may give them choices as hints, such as 10% land 90% water or 30% land 70% water. Point out that about 71% of the earth's surface is covered with water.

4. Ask the pupils how far down would a ship go if it sank in the deepest part of the ocean. Elicit a few guesses. Point out that the oceans are so deep that if a gigantic bulldozer could scrape all the land above water into the oceans the land would disappear completely.

5. Demonstrate the ability of sound to travel better through water than through air. Place the tuning fork as shown in each diagram below.



The pupils should observe that the tuning fork touching the water can be heard better than the one in the air. Point out that the ocean depths can be measured by sending sound waves through water. You may use the pupils' experiences to reinforce this idea. Point out that sound waves sent to the bottom of the ocean are timed. The deeper the water the longer it takes for the sound waves to return to the surface. Distribute pupil worksheets and guide them in each step of the investigation.

SUMMARY:

Have the pupils recall the names of the sunken ships. Elicit how we know how far down each ship has sunk. Have the pupils name land features that can be found underwater. The pupils should be aware of the irregular shape of the ocean floor. Elicit the approximate depth of the Atlantic Ocean off Puerto Rico. Point out that the Pacific Ocean has even deeper water, for example near the Phillipines it is about 7½ miles deep. Elicit that the oceans cover about 71% of the earth's surface.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 25. How deep is the ocean?

The drawing below shows what a part of the ocean bottom looks like.

1. See how many parts you can name. Write these names next to parts A, B, C, D, and E. Use the list of names shown below to name the parts.
   - continent
   - canyon or trench
   - island
   - offshore shelf

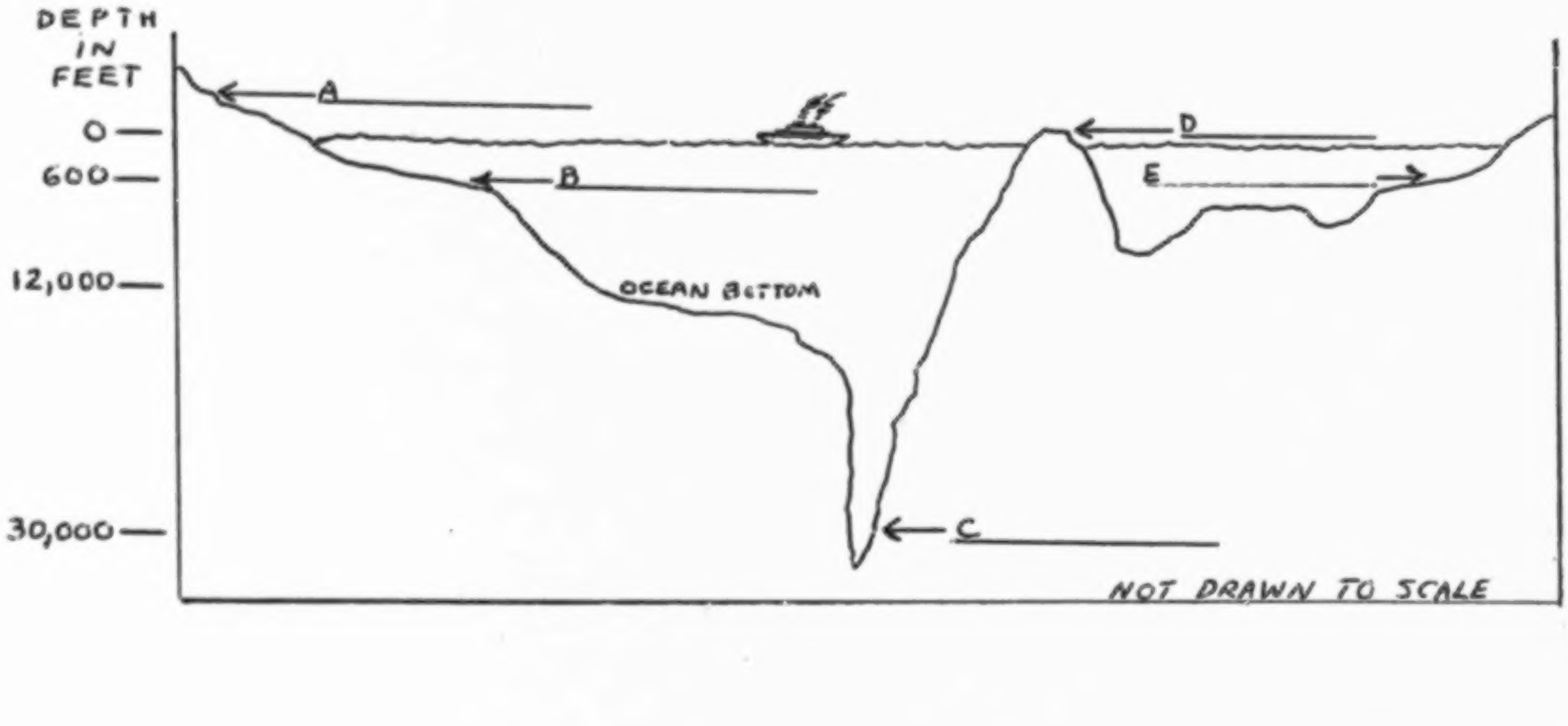
2. Look at the lines that show how deep each part is. How deep is each of these:

   a. offshore shelf ________________

   b. trench ________________

   c. ocean bottom ________________

THE SHAPE OF THE OCEAN FLOOR


DEPTH IN FEET
0
600
12,000
30,000
A
B
C
D
E
OCEAN BOTTOM
NOT DRAWN TO SCALE

F. OCEANS

LESSON 26. Are there rivers in the oceans?

OUTCOMES:

1. The movements of ocean waters are called currents.
2. Currents are caused by winds and temperature differences.
3. The Gulf Stream travels more than a thousand miles along the coast of the United States.

MATERIALS:

Teacher

two 500 ml. beakers
glass plate
large battery jar
two ice cubes made from water dyed red

Pupil

map of the currents in the Atlantic Ocean (see pupil worksheet)

PROCEDURE:

1. Ask the pupils, "What is a river?" Elicit that it is a flow of water. Ask the pupils for the names of some of the world's largest rivers. After a few responses such as the Mississippi, Amazon, and so on, tell the pupils that a much larger river is in the Atlantic Ocean. Try to elicit the name of this "river" from the pupils. Point out that the Gulf Stream moving off the coast of the United States moves much more water than the Mississippi.

2. Challenge the pupils to answer the question, "What makes the Gulf Stream move?" Use a large battery jar filled with cool water to show that temperature differences in water can result in the movement of water. Cover a filled beaker of reasonably hot tinted water with a glass plate. Hold the glass plate in place and set the beaker on the bottom of the battery jar. Slide the glass plate to the side. The pupils should observe the warm water rises

3. Place a tinted ice cube in a beaker of clear lukewarm water. Have the pupils note that the colder liquid (melting ice) sinks.

4. Draw a diagram on the board which shows the rising and sinking of warm and cold water.

5. Ask the pupils if they can guess what else could make the ocean waters move. Point out that steady winds blowing across the oceans cause the water to move. Show the path of the steady winds over the Atlantic Ocean by means of a simple diagram. Point out the great distances that ocean currents can travel around the Atlantic Ocean.

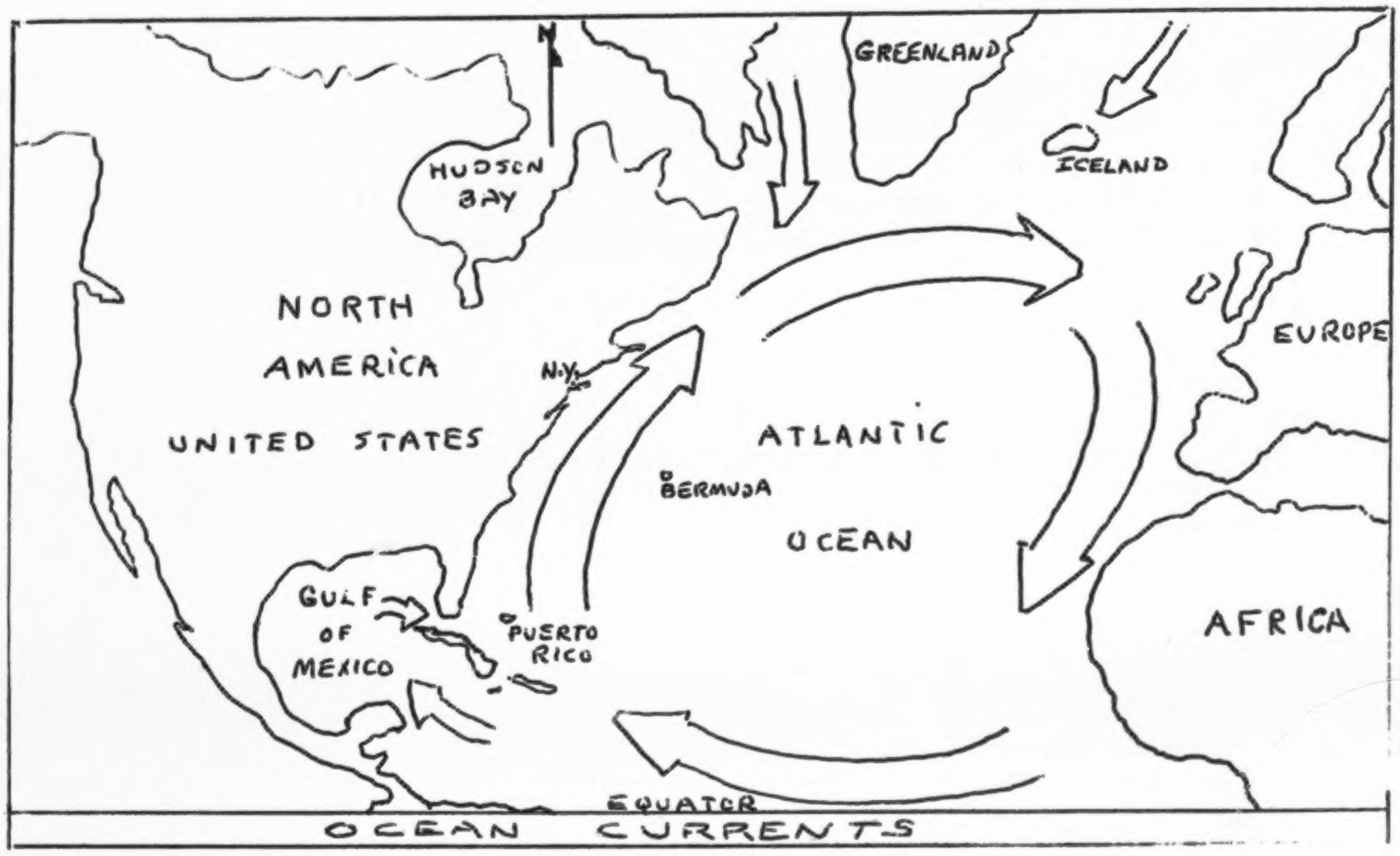
6. Distribute pupil worksheets. Read the directions and labels to the children. Discuss the completed worksheets with the children.

SUMMARY:

Have the pupils recall what causes the movement of the ocean waters. Elicit the path the ocean currents take. You may point out that the currents circle around the Atlantic because the land areas steer or guide them in a circular path.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 26. Where are the world's largest rivers?


N
GREENLAND
HUDSON BAY
ICELAND
NORTH AMERICA
N.Y.
UNITED STATES
EUROPE
ATLANTIC
BERMUDA
OCEAN
GULF OF MEXICO
PUERTO RICO
AFRICA
EQUATOR
OCEAN CURRENTS

Place the following names inside the arrows shown above.

1. Gulf Stream - travels north off the coast of the United States.
2. Labrador Current - travels south between Greenland and North America.
3. Canary Current - travels south along the coast of Africa.
4. North Atlantic Current - heads eastward across the Atlantic.
5. Equatorial Current - heads westward across the Atlantic Ocean.

F. OCEANS

LESSON 27. How do waves shape the land?

OUTCOMES:

1. Waves are usually formed by the wind.
2. Waves break down the land and carry it away.
3. Beach sand is formed from broken down rocks.
4. Waves wear away soft materials easier than hard materials.

MATERIALS:

Teacher

1 large tray (pneumatic trough, baking pan, other)
sand
1 rock (about 3" across)
1 12" ruler

Pupil

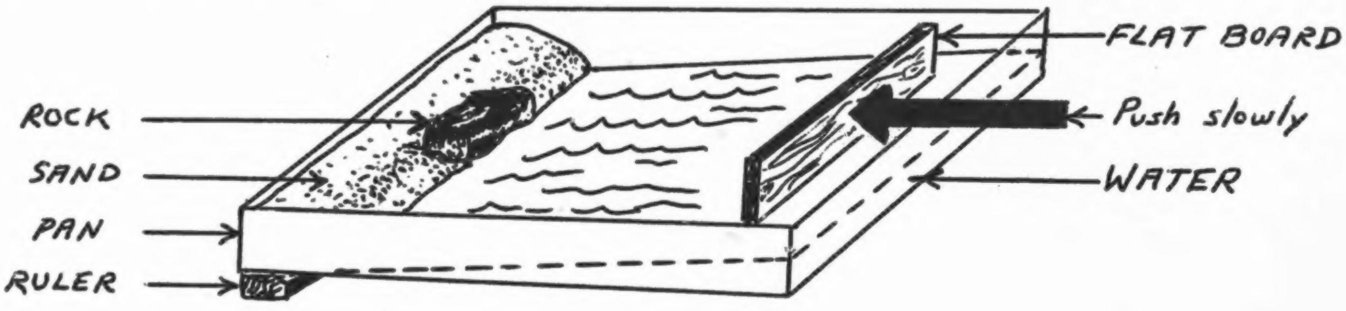
1 microscope
1 pinch of beach sand
1 deep well slide
1 sample of granite
1 sample of mica or mica schist
1 sample of olivine

PROCEDURE:

1. Tell the pupils about giant tidal waves caused by earthquakes. A recent tidal wave (in the 1960's) broke windows in a lighthouse on a cliff about 100 feet high.

2. Elicit pupil's experiences with waves when at the beach. Try to elicit the question - "Where do waves come from?" Point out that tidal waves are rare. Ordinary waves, seen at the beach, are caused by the wind. Have pupils describe their experiences with the power in waves such as being knocked down or having sand castles or forts destroyed by waves.

3. Demonstrate the effect waves have on shorelines by setting-up and operating the apparatus shown below.



Use the flat board to create waves. Have the pupils observe how the loose materials are easily washed away and how the solid material does not break down. Point out, however, that even cliffs made of solid rocks are slowly broken apart by the steady pounding of waves. Ask the pupils how they think beach sand was formed. After a brief discussion tell the pupils that they are going to study beach sand to try to find out where it came from. Distribute pupil worksheets and materials. Assist the pupils with the setting up of their slides and microscopes.

SUMMARY:

Discuss how waves may originate. Elicit that most waves are made by the wind. Elicit that waves wear away the land. Point out the harder materials break down more slowly. Point out that rocks and minerals can be broken into tiny bits. Elicit that the tiny bits of broken rocks can pile up to form sandy beaches.

PUPIL WORKSHEET
(MAY BE DUPLICATED FOR PUPILS)

LESSON 27. How did the beaches get their sand?

1. Place a pinch of beach sand in the well of the slide.
2. Study the sand under the microscope.
3. Look at the color and shape of the bits of sand.

Check off, in Box A, the things listed below that you can see.

Sand Grains	Box A	Box B
a. Colorless bits of glass		
b. Pink or white blocks		
c. Black flakes		
d. Blue or purple bits of glass		
e. Dull red		
f. Green		
g. Black blocks		

4. Look at the following rocks and minerals. They were dug out of the solid earth. Check off each thing under SAND GRAINS above that you can see in these rocks. (column B)

QUESTIONS:

1. Some of the bits of sand look somewhat like (all, some, none) ____________ of the rocks and minerals.

2. Rocks and minerals are broken down into tiny bits called _______.

3. The sand in the beaches comes from __________________.